

**Semrock** A Unit  
of IDEX

The Standard in Optical Filters for Biotech & Analytical Instrumentation

## 2009 – 2010 Master Catalog



Fluorescence Filters  
Raman Spectroscopy Filters  
Laser Analytical Instrumentation Filters

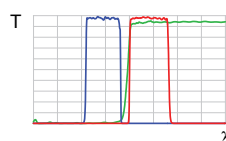
# How to Find the Right Filter in This Catalog

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Try our flexible  
filter plotting tool at  
[www.semrock.com](http://www.semrock.com)

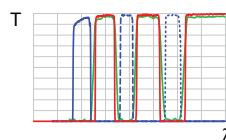
## Application & Filter Type

### Fluorescence Filters



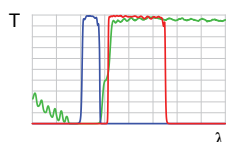
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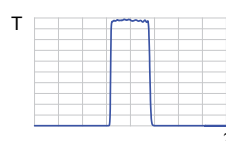


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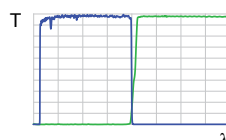


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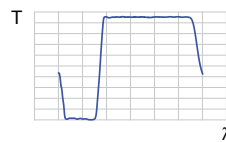
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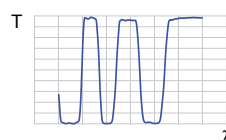
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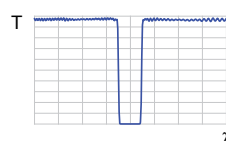
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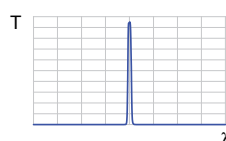
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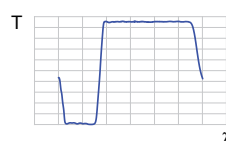
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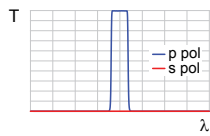


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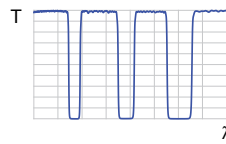
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# How to Find the Right Filter in This Catalog

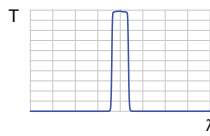
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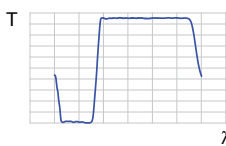
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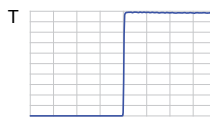
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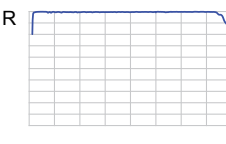
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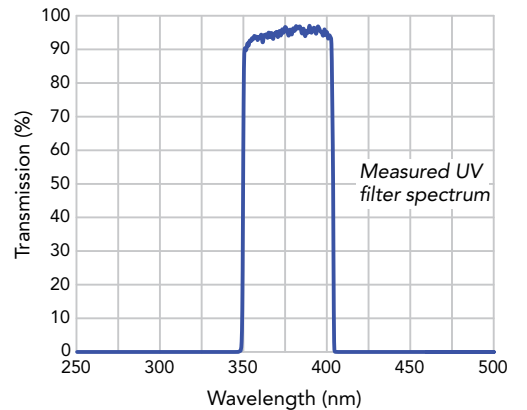
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# The Standard in Optical Filters for Biotech & Analytical Instrumentation

## Superior Performance



Semrock successfully combines the most sophisticated and modern ion-beam-sputtering deposition systems, renowned for their stability, with its own proprietary deposition control technology, unique predictive algorithms, process improvements, and volume manufacturing capability. The result is optical filters of unsurpassed performance that set the standard for the Biotech and Analytical Instrumentation industries. These filters are so exceptional that they are patented and award-winning. We never stop innovating.



Semrock's no burn-out optical filters are all made with ion-beam sputtering and our exclusively single-substrate construction for the highest transmission on the market. And steeper edges, precise wavelength accuracy, and carefully optimized blocking mean better contrast and faster measurements – even at UV wavelengths.

## Proven Reliability

All Semrock filters demonstrate exceptional reliability. The simple all-glass structure combined with ion-beam-sputtered hard glass coatings (as hard as the glass on which they are coated) mean they are virtually impervious to humidity and temperature induced degradation. Plus, Semrock filters don't "burn out" (see page 6) and they can be readily cleaned and handled (learn how – see page 33).

## Five Year Warranty

Semrock confidently backs our filters with a comprehensive five-year warranty. Built to preserve their high level of performance in test after test, year after year, our filters reduce your cost of ownership by eliminating the expense and uncertainty of replacement costs.

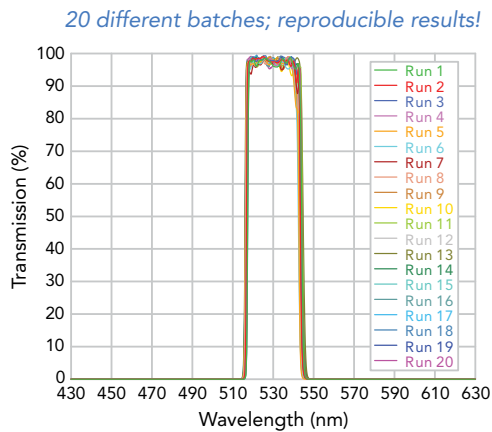
Environmental Durability Testing	Mil Spec Standard / Procedure
Humidity	MIL-STD-810F (507.4)
High Temperature	MIL-STD-810F (501.4)
Low Temperature	MIL-STD-810F (502.4)
Physical Durability Testing	Mil Spec Standard / Procedure
Adhesion	MIL-C-48497A (4.5.3.1)
Humidity	MIL-C-48497A (4.5.3.2)
Moderate Abrasion	MIL-C-48497A (4.5.3.3)
Solubility/Cleanability	MIL-C-48497A (4.5.4.2)
Water Solubility	MIL-C-48497A (4.5.5.3)

Semrock filters have been tested to meet or exceed the requirements for environmental and physical durability set forth in the demanding U.S. Military specifications MIL-STD-810F, MIL-C-48497A, MIL-C-675C, as well as the international standard ISO 9022-2.

# Hundreds of Thousands of Ion Beam Sputtered Filters Delivered

## Repeatable Results

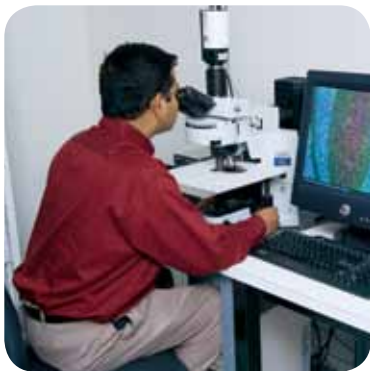
Batch-to-batch reproducibility. Whether you are using a filter from the first run or the last, the results will always be the same. Our highly automated volume manufacturing systems closely monitor every step of our processes to ensure quality and performance of each and every filter. End users never need to worry whether results will vary when setting up a new system, and OEM manufacturers can rely on a secure supply line.



## Extensive Inventory

Need optical filters ASAP? No problem. Semrock stocks most of the items in our catalog. Look for the "These items ship same day!" flag wherever applicable. Place your order by noon (EST) for same day shipping.

These items ship same day!



## 30-day Return Policy

We have shipped hundreds of thousands of ion-beam-sputtered filters to many happy customers, but if you are not fully satisfied with your purchase simply request an RMA number within 30 days from the date of shipment. Does not apply to custom-sized parts. [www.semrock.com/ContactUs/](http://www.semrock.com/ContactUs/)



## Rapid Custom-sizing Service

Semrock has refined its manufacturing process for small volumes of custom-sized parts to allow rapid turn-around. Most catalog items are available in a wide range of circular or rectangular custom sizes in less than one week. Please contact us directly to discuss your specific needs.

# BrightLine® Single-band Sets for Popular Fluorophores

For a complete list, see [www.semrock.com](http://www.semrock.com)



Primary Fluorophores	Peak EX	Peak EM	Recommended BrightLine Sets	Page
5-FAM (5-carboxyfluorescein)	492	518	FITC-3540B	9
5-ROX (carboxy-X-rhodamine)	580	605	TXRED-4040B or TXRED-A-Basic	10 22
5-TAMRA (5-carboxytetramethyl-rhodamine, high pH > 8)	542	568	TRITC-A	10
Alexa Fluor® 350	346	442	DAPI-1160A or DAPI-5060B or BFP-A-Basic	9 9 21
Alexa Fluor® 405	402	421	DAPI-1160A or DAPI-5060B	9 9
Alexa Fluor® 488	495	519	FITC-3540B or FITC-A-Basic	9 21
Alexa Fluor® 532	531	554	TRITC-A	10
Alexa Fluor® 546	556	573	TRITC-A or TRITC-A-Basic	10 22
Alexa Fluor® 555	555	565	CY3-4040B	10
Alexa Fluor® 568	578	603	TXRED-4040B or TXRED-A-Basic	10 22
Alexa Fluor® 594	590	617	TXRED-4040B or TXRED-A-Basic	10 22
Alexa Fluor® 647	650	668	CY5-4040A	10
Alexa Fluor® 660	663	690	CY5-4040A	10
Alexa Fluor® 680	679	702	CY5.5-A	10
Alexa Fluor® 750	749	775	CY7-A	11
AMCA / AMCA-X	350	450	DAPI-1160A or DAPI-5060B or BFP-A-Basic	9 9 21
AmCyan	454	488	CFP-2432A	9
BFP	380	435	DAPI-1160A or DAPI-5060B or LF405-A or BFP-A-Basic	9 9 13 21
BODIPY	505	513	FITC-3540B or FITC-A-Basic	9 22
Calcofluor White	350	440	DAPI-1160A or DAPI-5060B or CFW-LP01 or CFW-BP01	9 9 21 21
Cascade Blue™	401	420	DAPI-1160A or DAPI-5060B	9 9
CFP (cyan GFP)	434	477	CFP-2432A or CFP-A-Basic	9 21

Primary Fluorophores	Peak EX	Peak EM	Recommended BrightLine Sets	Page
Cerulean	434	475	CFP-2432A or CFP-A-Basic	9 21
CoralHue Kusabira Orange	548	559	CY3-4040B	10
Cy2™	489	506	GFP-3035B or GFP-A-Basic	9 22
Cy3™	552	570	CY3-4040B or LF561-A	10 13
Cy3.5™	580	591	Cy3.5-A-Basic or TXRED-4040B	22 10
Cy5™	649	666	CY5-4040A or LF635-A	10 13
Cy5.5™	676	690	CY5.5-A	10
Cy7™	753	775	CY7-A	11
DAPI	359	461	DAPI-1160A or DAPI-5060B or BFP-A-Basic or LF405-A	9 9 21 13
DEAC	432	472	SpAqua-A	16
DsRed Monomer	556	586	CY3-4040B	10
DsRed2	563	582	CY3-4040B	10
DsRed-Express	557	579	CY3-4040B	10
dTomato	554	581	TRITC-A or CY3-4040B or TRITC-A-Basic	10 10 21
EBFP	380	440	DAPI-1160A or DAPI-5060B	9 9
ECFP	434	477	CFP-2432A	9
EGFP	489	508	GFP-3035B or GFP-A-Basic or LF488-A	9 21 13
Emerald	490	510	FITC-3540B or GFP-3035B	9 9
EYFP	513	527	YFP-2427A or YFP-A-Basic	10 22
FAM	492	518	FITC-3540B or FITC-A-Basic	9 21
Fast Blue	360	440	DAPI-1160A or DAPI-5060B	9 9
FITC (Fluorescein)	492	520	FITC-3540B or FITC-A-Basic or LF488-A	9 21 13
Fluo-3	506	526	YFP-2427A or YFP-A-Basic	10 22
Fura-2	363, 335	512, 505	FURA2-B	9
Fura Red™ (high pH)	572	657	TXRED-4040B	10
GFP (EGFP)	489	508	GFP-3035B or GFP-A-Basic or LF488-A	9 21 13

# BrightLine® Single-band Sets for Popular Fluorophores

For a complete list, see [www.semrock.com](http://www.semrock.com)

Primary Fluorophores	Peak EX	Peak EM	Recommended BrightLine Sets	Page	Primary Fluorophores	Peak EX	Peak EM	Recommended BrightLine Sets	Page
HcRed	590	614	TXRED-4040B	10	Qdot® 625 Nanocrystals	UV-Blue	625	QD625-A or QDLP-A	17 17
Hoechst 33258	362	485	DAPI-1160A or DAPI-5060B or BFP-A-Basic	9 9 21	Qdot® 655 Nanocrystals	UV-Blue	655	QD655-A or QDLP-A	17 17
Hoechst 33342	352	485	DAPI-1160A or DAPI-5060B or BFP-A-Basic	9 9 21	Rhodamine	550	573	TRITC-A or TRITC-A-Basic	10 22
Hoechst 34580	392	440	DAPI-1160A or DAPI-5060B or BFP-A-Basic	9 9 21	Rhodamine Green	502	527	YFP-2427A	10
ICG	768	807	ICG-A	11	ROX	568	595	CY3-4040B	10
Lidocaine	265	400	TRP-A	9	SNARF (carboxy) 488 Excitation pH6	549	589	CY3-4040B	10
LysoTracker Green	504	511	FITC-3540B	9	SNARF (carboxy) 514 Excitation pH6	549	586	CY3-4040B	10
LysoTracker Red	577	592	CY3-4040B	10	SNARF (carboxy) Excitation pH9	576	639	TXRED-4040B	10
mCherry (mRFP)	587	610	mCherry-A or TXRED-A-Basic or LF561-A	10 22 13	Sodium Green	506	532	FITC-3540B	9
mHoneydew	478	561	FITC-3540B or YFP-2427A	9 10	SpectrumAqua™	433	480	SpAqua-A	16
mOrange	548	568	TRITC-A or CY3-4040B	10 10	SpectrumFRed™ (Far Red)	655	675	Cy5-4040A	10
mPlum	594	648	TXRED-4040B	10	SpectrumGold™	530	555	SpGold-A	16
mStrawberry	575	596	TRITC-A or CY3-4040B or Cy3.5-A-Basic	10 10 22	SpectrumGreen™	497	538	SpGr-A	16
mTangerine	568	585	TRITC-A or CY3-4040B	10 10	SpectrumOrange™	559	588	SpOr-A	16
MitoTracker™ Green	490	516	FITC-3540B	9	SpectrumRed™	587	612	SpRed-A	16
MitoTracker™ Orange	551	576	CY3-4040B	10	Sulphorhodamine B can C	520	595	TRITC-A	10
MitoTracker™ Red	578	599	TXRED-4040B	10	TAMRA	565	580	CY3-4040B	10
Nicotine	270	390	TRP-A	9	Texas Red®	595	615	TXRED-4040B or TXRED-A-Basic or LF561-A	10 22 13
Nile Red	549	628	TRITC-A or TXRED-4040B	10 10	TRITC (Tetramethylrhodamine)	555	580	TRITC-A	10
Oregon Green™	503	522	FITC-3540B	9	TRITC (Tetramethylrhodamine) - "reddish" appearance	545	620	TRITC-A-Basic	22
Oregon Green™ 488	496	524	FITC-3540B	9	Tryptophan	295	340	TRP-A	9
Oregon Green™ 500	497	517	FITC-3540B	9	wtGFP	475	509	WGFP-A-Basic	21
Oregon Green™ 514	511	530	FITC-3540B	9	YFP (yellow GFP)	513	527	YFP-2427A or YFP-A-Basic	10 22
Phycoerythrin (PE)	567	576	CY3-4040B	10	Zs Yellow1	529	539	YFP-2427A or YFP-A-Basic	10 22
Qdot® 525 Nanocrystals	UV-Blue	525	QD525-A or QDLP-A	17 17					
Qdot® 605 Nanocrystals	UV-Blue	605	QD605-A or QDLP-A	17 17					

# BrightLine® Fluorescence Filters

## Hard-coated Durability – The *no burn-out* promise

- ▶ Can be cleaned and handled, even with acetone
- ▶ Impervious to humidity, insensitive to temperature
- ▶ No soft coatings – *no exceptions*

## No *burn-out*, no periodic replacement needed

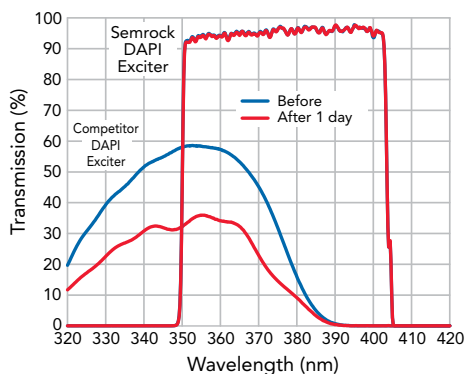


- ▶ Stand up to intense xenon, mercury, metal halide, LED, and halogen light sources
- ▶ No adhesives in the optical path to darken or degrade
- ▶ Made with the same refractory materials as our high “laser damage threshold” laser optics

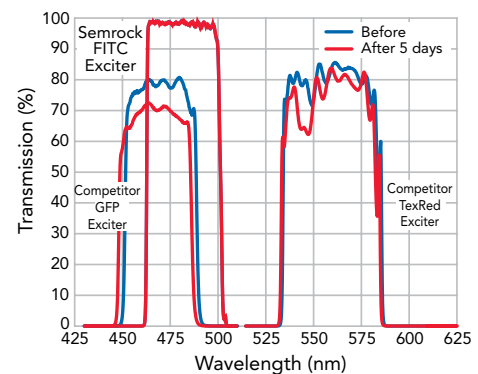
Tests were performed to illustrate the resistance to optical damage of Semrock’s hard-coated filters as compared to that of a leading competitor’s soft-coated and absorbing glass filters. Continuous irradiation from a conventional xenon arc lamp was used for the testing.

The graph on the bottom left shows how a leading competitor’s DAPI exciter filter can become severely burned out even after only one day of exposure to  $8 \text{ W/cm}^2$  of total intensity – here the transmission has dropped by 42%! By contrast, the Semrock DAPI exciter is unchanged. Exposure of these two filters was continued with  $1 \text{ W/cm}^2$  of total intensity (closely simulating the intensity seen by an exciter near the arc lamp source in a typical fluorescence microscope). The photographs above show that the competitor’s DAPI exciter failed catastrophically after 300 hours – both the large crack and burn-out degradation go all the way through the filter. The Semrock filter is again unchanged even after more than 1000 hours of exposure.

The graph at bottom right shows that a leading competitor’s soft-coated filters for visible wavelengths also show significant degradation after optical exposure, even at the intensity levels typical of most fluorescence microscopes. The transmission of these filters drops, and the spectra shift in wavelength. As always, the *Semrock hard-coated filter shows no change*.



Transmission spectra of DAPI exciter before (blue) and after (red) exposure to  $8 \text{ W/cm}^2$  (over 15 mm diameter) for 1 day.



Transmission spectra of soft-coated exciter (for GFP and Texas Red) compared to a Semrock hard-coated exciter (for FITC) before (blue) and after (red) exposure to  $1 \text{ W/cm}^2$  (over 25 mm diameter) for 5 days.



# BrightLine® Single-band Sets

Extensive selection.  
30-day return policy.



## When you want the best.

We stock a wide selection of filter sets optimized for the most popular fluorophores and fluorescence microscopes and imaging systems.

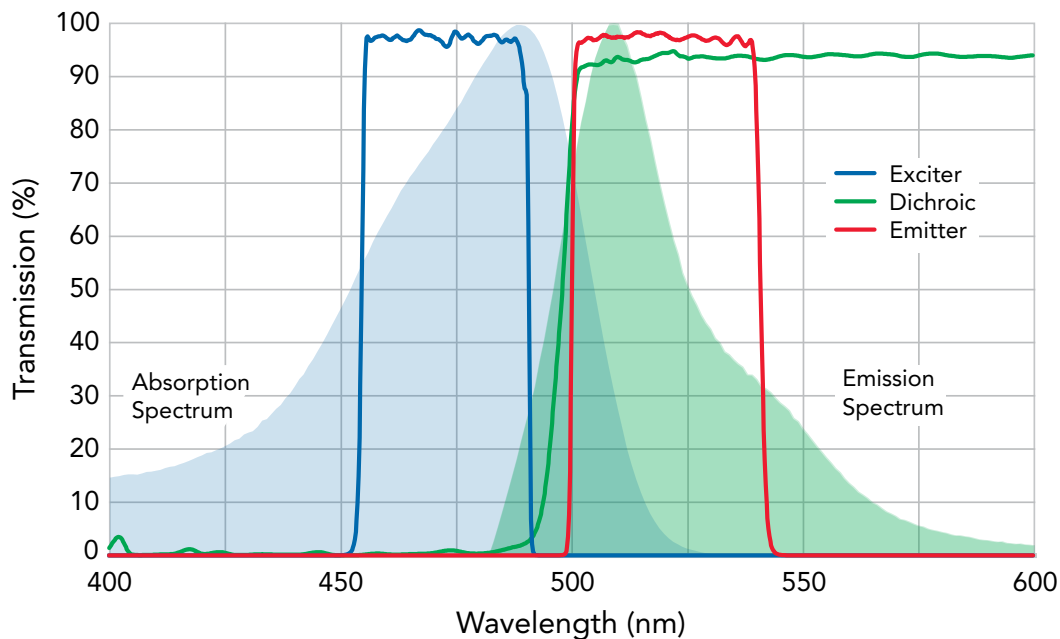
High transmission, steeper edges, precise wavelength accuracy and carefully optimized blocking mean better contrast and faster measurements.

Whether you need the brightest filters available, or the most contrast, these high-performance sets meet all your needs.

We also stock a wide selection of individual bandpass filters and beamsplitters which may be combined for non-standard applications (*starting on page 37*).

## Spectacular Spectra

Typical measured GFP-3035B Filter Set for Green Fluorescent Protein. Hard-coating technology combined with single-substrate filter construction results in the highest transmission on the market.



## Custom Sizing:

Our manufacturing process allows us to offer custom sizing for most catalog filters. Orders ship within one week. Please contact us directly to discuss your specific needs.

## 30 Day Return Policy:

We have shipped hundreds of thousands of ion-beam-sputtered filters to many happy customers, but if you are not fully satisfied with your purchase simply request an RMA number within 30 days from the date of shipment. Does not apply to custom-sized parts. You may also download the form here: [www.semrock.com/ContactUs](http://www.semrock.com/ContactUs)

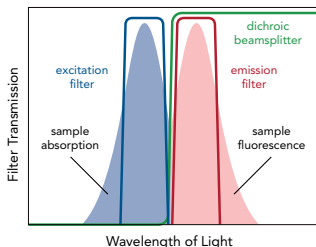
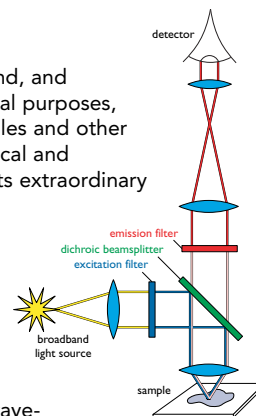
See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

## TECHNICAL NOTE

### Introduction to Fluorescence Filters

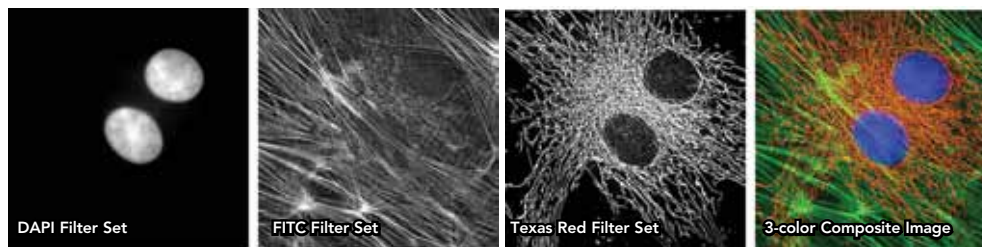
Optical fluorescence occurs when a molecule absorbs light at wavelengths within its absorption band, and then nearly instantaneously emits light at longer wavelengths within its emission band. For analytical purposes, strongly fluorescing molecules known as fluorophores are specifically attached to biological molecules and other targets of interest to enable quantification, identification, and even real-time observation of biological and chemical activity. Fluorescence is widely used in biotechnology and analytical applications due to its extraordinary sensitivity, high specificity, and simplicity.

Most fluorescence instruments, including fluorescence microscopes, are based on optical filters. A typical system has three basic filters: an excitation filter (or exciter), a dichroic beamsplitter, and an emission filter (or emitter). The exciter is typically a bandpass filter that passes only the wavelengths absorbed by the fluorophore, thus minimizing excitation of other sources of fluorescence and blocking light in the fluorescence emission band. The dichroic is an edge filter used at an oblique angle of incidence (typically 45°) to efficiently reflect light in the excitation band and to transmit light in the emission band. The emitter is typically a bandpass filter that passes only the wave-

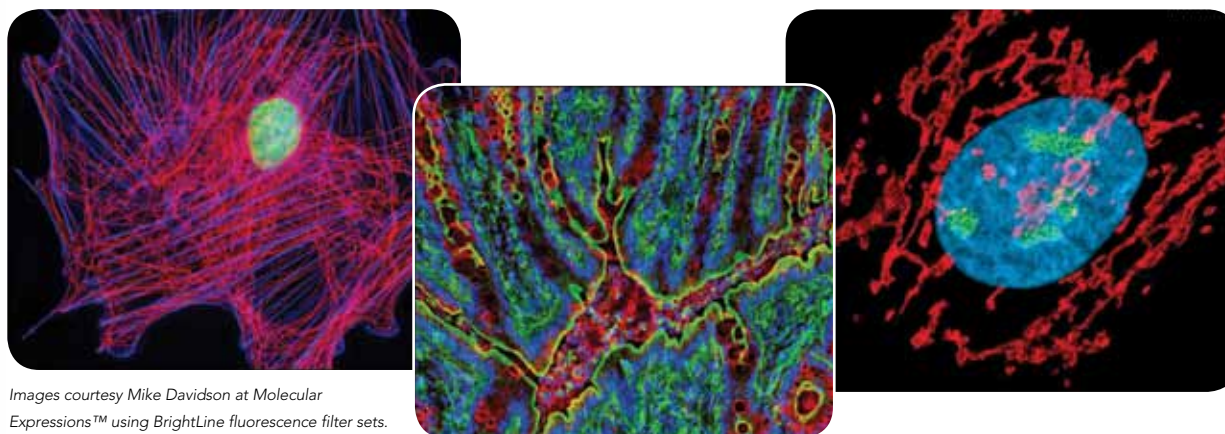


lengths emitted by the fluorophore and blocks all undesired light outside this band – especially the excitation light.

In most fluorescence instruments, the best performance is obtained with thin-film filters, which are comprised of multiple alternating thin layers of transparent materials with different indexes of refraction on a glass substrate. The complex layer structure determines the spectrum of light transmission by a filter. Thin-film filters are simple to use, inexpensive, and provide excellent optical performance: high transmission over an arbitrarily determined bandwidth, steep edges, and high blocking of undesired light over the widest possible wavelength range. Advances in thin-film filter technology pioneered by Semrock, and embodied in all BrightLine® filters, permit even higher performance while resolving the longevity and handling issues that can plague filters made with older soft-coating technology (see page 6). And this advanced technology is so flexible that users have a choice between the highest-performance flagship BrightLine filter sets (see page 6) and the best-value BrightLine Basic™ filter sets (see page 20).



Multicolor composite images are created by separately capturing monochrome images with a low-noise, cooled CCD camera using individual filter sets, and then combining the images using software. This 3-color composite image was created using BrightLine DAPI-5060B, FITC-3540B, and TxRed-4040B filter sets (see pages 9 & 10).



Images courtesy Mike Davidson at Molecular Expressions™ using BrightLine fluorescence filter sets.

# BrightLine® Single-band Sets

Extensive selection.  
30-day return policy.

**These items ship same day!**

Set / Primary Fluorophores		Center Wavelength / Nominal Edge Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>TRP-A</b>  <b>Tryptophan</b>  <i>Designed for UV fluorescence Use with UV LED or filtered Xe arc lamps, or detectors not sensitive to near-IR light.</i>	Exciter	280 nm	> 65% over 20 nm	FF01-280/20-25
	Emitter	357 nm	> 75% over 44 nm	FF01-357/44-25
	Dichroic	310 nm (edge)	R <sub>avg</sub> > 98% 255 – 295 nm T <sub>avg</sub> > 90% 315 – 600 nm	FF310-Di01-25x36
	<b>Unmounted Full Set:</b>			<b>TRP-A-000</b>
<b>DAPI-1160A</b>  <b>DAPI, Hoechst, AMCA, BFP, Alexa Fluor® 350</b>  <i>Highest Contrast</i>  <i>Contact Semrock about 32 mm exciter.</i>	Exciter	387 nm	> 90% over 11 nm	FF01-387/11-25
	Emitter	447 nm	> 93% over 60 nm	FF02-447/60-25
	Dichroic	409 nm (edge)	R <sub>avg</sub> > 98% 344 – 404 nm T <sub>avg</sub> > 90% 415 – 570 nm	FF409-Di02-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>DAPI-1160A-000</b> <b>DAPI-1160A-000-ZERO</b>
<b>DAPI-5060B</b>  <b>DAPI, Hoechst, AMCA, BFP, Alexa Fluor® 350</b>  <i>Highest Brightness</i>	Exciter	377 nm	> 85% over 50 nm	FF01-377/50-25
	Emitter	447 nm	> 93% over 60 nm	FF02-447/60-25
	Dichroic	409 nm (edge)	R <sub>avg</sub> > 98% 344 – 404 nm T <sub>avg</sub> > 90% 415 – 570 nm	FF409-Di02-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>DAPI-5060B-000</b> <b>DAPI-5060B-000-ZERO</b>
<b>CFP-2432A</b>  <b>CFP, AmCyan, SYTOX Blue, BOBO-1, BO-PRO-1</b>	Exciter	438 nm	> 93% over 24 nm	FF01-438/24-25
	Emitter	483 nm	> 93% over 32 nm	FF01-483/32-25
	Dichroic	458 nm (edge)	R <sub>avg</sub> > 98% 426 – 450 nm T <sub>avg</sub> > 90% 467 – 600 nm	FF458-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>CFP-2432A-000</b> <b>CFP-2432A-000-ZERO</b>
<b>FURA2-B</b>  <b>Fura-2 Ca<sup>2+</sup> indicator, LysoSensor Yellow/Blue</b>  <i>Four filter set</i>	Exciter 1	340 nm	> 75% over 26 nm	FF01-340/26-25
	Exciter 2	387 nm	> 90% over 11 nm	FF01-387/11-25
	Emitter	510 nm	> 93% over 84 nm	FF01-510/84-25
	Dichroic	409 nm (edge)	R <sub>avg</sub> > 98% 344 – 404 nm T <sub>avg</sub> > 90% 415 – 570 nm	FF409-Di02-25x36
<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>FURA2-B-000</b> <b>FURA2-B-000-ZERO</b>	
<b>GFP-3035B</b>  <b>GFP, EGFP, DiO, Cy2™, YOYO-1, YO-PRO-1</b>	Exciter	472 nm	> 93% over 30 nm	FF01-472/30-25
	Emitter	520 nm	> 93% over 35 nm	FF01-520/35-25
	Dichroic	495 nm (edge)	R <sub>avg</sub> > 98% 442 – 488 nm T <sub>avg</sub> > 90% 502 – 730 nm	FF495-Di02-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>GFP-3035B-000</b> <b>GFP-3035B-000-ZERO</b>
<b>FITC-3540B</b>  <b>FITC, rsGFP, Bodipy, FAM, Fluo-4, Alexa Fluor® 488</b>	Exciter	482 nm	> 93% over 35 nm	FF01-482/35-25
	Emitter	536 nm	> 93% over 40 nm	FF01-536/40-25
	Dichroic	506 nm (edge)	R <sub>avg</sub> > 98% 446 – 500 nm T <sub>avg</sub> > 90% 513 – 725 nm	FF506-Di02-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>FITC-3540B-000</b> <b>FITC-3540B-ZERO</b>



# BrightLine® Single-band Sets

Every Semrock filter is hard-coated for *no burn-out* performance.  
Five-year warranty.

**These items ship same day!**

Set / Primary Fluorophores		Center Wavelength / Nominal Edge Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>YFP-2427A</b>  YFP, Calcium Green-1, Eosin, Fluo-3, Rhodamine 123	Exciter	500 nm	> 93% over 24 nm	FF01-500/24-25
	Emitter	542 nm	> 93% over 27 nm	FF01-542/27-25
	Dichroic	520 nm (edge)	R <sub>avg</sub> > 98% 488 – 512 nm T <sub>avg</sub> > 90% 528 – 655 nm	FF520-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>YFP-2427A-000</b> YFP-2427A-000-ZERO
<b>TRITC-A</b>  TRITC, Rhodamine, Dil, 5-TAMRA, Alexa Fluor® 532 & 546	Exciter	543 nm	> 93% over 22 nm	FF01-543/22-25
	Emitter	593 nm	> 93% over 40 nm	FF01-593/40-25
	Dichroic	562 nm (edge)	R <sub>avg</sub> > 98% 499 – 555 nm T <sub>avg</sub> > 90% 569 – 730 nm	FF562-Di02-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>TRITC-A-000</b> TRITC-A-000-ZERO
<b>Cy3-4040B</b>  Cy3™, DsRed, PE, TAMRA, Calcium Orange, Alexa Fluor® 555	Exciter	531 nm	> 93% over 40 nm	FF01-531/40-25
	Emitter	593 nm	> 93% over 40 nm	FF01-593/40-25
	Dichroic	562 nm (edge)	R <sub>avg</sub> > 98% 499 – 555 nm T <sub>avg</sub> > 90% 569 – 730 nm	FF562-Di02-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>Cy3-4040B-000</b> Cy3-4040B-000-ZERO
<b>TXRED-4040B</b>  Texas Red®, Cy3.5™, 5-ROX, Mitotracker Red, Alexa Fluor® 568 & 594	Exciter	562 nm	> 93% over 40 nm	FF01-562/40-25
	Emitter	624 nm	> 93% over 40 nm	FF01-624/40-25
	Dichroic	593 nm (edge)	R <sub>avg</sub> > 98% 530 – 585 nm T <sub>avg</sub> > 90% 601 – 800 nm	FF593-Di02-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>TXRED-4040B-000</b> TXRED-4040B-000-ZERO
<b>mCherry-A</b>  mCherry (mRFP)	Exciter	562 nm	> 93% over 40 nm	FF01-562/40-25
	Emitter	641 nm	> 93% over 75 nm	FF01-641/75-25
	Dichroic	593 nm (edge)	R <sub>avg</sub> > 98% 530 – 585 nm T <sub>avg</sub> > 90% 601 – 800 nm	FF593-Di02-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>mCherry-A-000</b> mCherry-A-000-ZERO
<b>Cy5-4040A</b>  Cy5™, APC, DiD, Alexa Fluor® 647 & 660	Exciter	628 nm	> 93% over 40 nm	FF01-628/40-25
	Emitter	692 nm	> 93% over 40 nm	FF01-692/40-25
	Dichroic	660 nm (edge)	R <sub>avg</sub> > 98% 594 – 651 nm T <sub>avg</sub> > 90% 669 – 726 nm	FF660-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>Cy5-4040A-000</b> Cy5-4040A-000-ZERO
<b>Cy5.5-A</b>  Cy5.5™, Alexa Fluor® 680	Exciter	655 nm	> 93% over 40 nm	FF01-655/40-25
	Emitter	716 nm	> 93% over 40 nm	FF01-716/40-25
	Dichroic	685 nm (edge)	R <sub>avg</sub> > 98% 600 – 676 nm T <sub>avg</sub> > 90% 695 – 810 nm	FF685-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>Cy5.5-A-000</b> Cy5.5-A-000-ZERO



(continued) Filter Specifications on page 34

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# BrightLine® Single-band Sets

Extensive selection.  
30-day return policy.

**These items ship same day!**

Set / Primary Fluorophores		Center Wavelength / Nominal Edge Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>Cy7-A</b> Cy7™, Alexa Fluor® 750	Exciter	710 nm	> 93% over 40 nm	FF01-710/40-25
	Emitter	775 nm	> 93% over 46 nm	FF01-775/46-25
	Dichroic	741 nm (edge)	R <sub>avg</sub> > 98% 660 – 731.5 nm T <sub>avg</sub> > 90% 750.5 – 810 nm	FF741-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>Cy7-A-000</b> Cy7-A-000-ZERO
<b>ICG-A</b> Indocyanin Green	Exciter	769 nm	> 93% over 41 nm	FF01-769/41-25
	Emitter	832 nm	> 93% over 37 nm	FF01-832/37-25
	Dichroic	801 nm (edge)	R <sub>avg</sub> > 98% 749 – 790 nm T <sub>avg</sub> > 90% 813.5 – 885 nm	FF801-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>ICG-A-000</b> ICG-A-000-ZERO

Filter Specifications on page 34

## BrightLine ZERO™ Fluorescence Filter Sets

Only \$99 ensures exact image registration when making multi-color composite images with BrightLine single-band sets. Not sure you need this? Keep in mind that BrightLine filters do not burn out, and the -ZERO option requires no calibration or special alignment, so why not cost-effectively future-proof your system? Join your many colleagues and demand the "-ZERO option" for certified image registration. To order, just add "-ZERO" to the end of the filter set part number.

- ▶ Allows you to create spacially registered multi-color composite images
- ▶ Hard coated for durability and reliability
- ▶ Ideal for demanding applications like:

Co-localization fluorescence measurements – see page 19

Fluorescence In Situ Hybridization (FISH) – see page 15

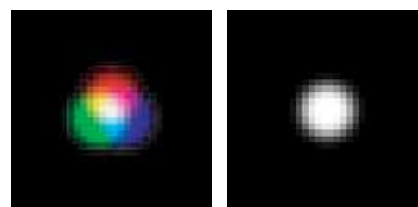
Comparative Genomic Hybridization (CGH)

Property	Value	Comment	Price
Set-to-set Image Shift	< ± 1 pixel	Worst case image shift when interchanging BrightLine ZERO filter sets, as measured relative to the mean image position for a large sample of filter sets. Analysis assumes collimated light in a standard microscope with a 200 mm focal length tube lens and 6.7 micron pixel size. Tested in popular microscope cubes.	+ \$99 to the set price

## TECHNICAL NOTE

### What is Pixel Shift?

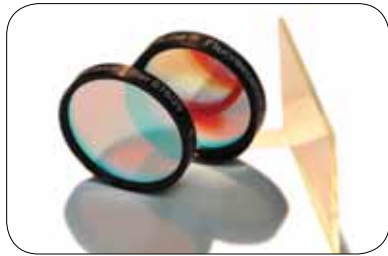
Pixel shift results when a filter in an imaging path (the emitter and/or dichroic beamsplitter in a fluorescence microscope) with a non-zero wedge angle deviates the light rays to cause a shift of the image detected on a high-resolution CCD camera. When two or more images of the same object acquired using different filter sets are overlaid (in order to simultaneously view fluorescence from multiple fluorophores), any significant non-zero filter wedge angle means that the images will not be registered to identical pixels on the CCD camera. Hence, images produced by different fluorophores will not be accurately correlated or combined. Unlike older, soft-coated fluorescence filters, Semrock's advanced ion-beam-sputtering coating technology makes it possible for all BrightLine filters to be uniquely constructed from a single piece of glass, with the permanent hard coatings applied directly to the outside. This patented (U.S. Patent Nos. 6,809,859, 7,411,679, and pending) lower-loss and high-reliability construction inherently enables BrightLine ZERO filter sets to be manufactured, tested and certified to very tight tolerances so as to ensure accurate image registration every time.



Composite images produced from conventional filter sets (above left), which typically have significant pixel shift, are distorted, whereas BrightLine ZERO pixel shift filter sets (above right) yield precise multi-color images.

# BrightLine® Laser Fluorescence Single-band Sets

Every Semrock filter is hard-coated for *no burn-out* performance.  
Five-year warranty.



- ▶ Filter **wavelengths precisely keyed** to popular laser lines, with steep transitions from laser blocking to fluorescence transmission
- ▶ **Exceptionally high transmission** to maximize system throughput, thus reducing acquisition time
- ▶ **Deep blocking** at laser wavelengths to minimize noise background
- ▶ Dichroic beamsplitters suppress axial focal shift and aberrations for reflected laser light (*See Technical Note on page 47*)
- ▶ **Long-pass sets** allow for longer wavelengths to be detected and more light to be captured

## Applications for BrightLine Laser Fluorescence Filter Sets include:

- Laser-scanning confocal microscopes (e.g. Olympus FluoView FV300, FV1000; Nikon Eclipse C1 Plus/si, A1)
- Spinning-disk confocal microscopes (e.g. BD Biosciences CARV II; Olympus DSU)
- Total-internal-reflection fluorescence (TIRF) microscopes (e.g. Olympus TIRF Illuminator, FV1000-EVA; Nikon TIRF)
- Structured illumination microscopes (e.g. Qioptiq OptiGrid®)

BrightLine Laser Fluorescence filter sets are optimized for laser excitation and inherently provide excellent image registration performance – when interchanging these sets with one another, minimal pixel shift is observed. Note that the laser filter sets are not designed to exhibit “zero pixel shift” performance when interchanging with BrightLine ZERO™ filter sets. Images obtained with the laser filter sets do exhibit excellent image registration not only with one another, but also with images obtained when no fluorescence filters are present (e.g., DIC or other brightfield modes).

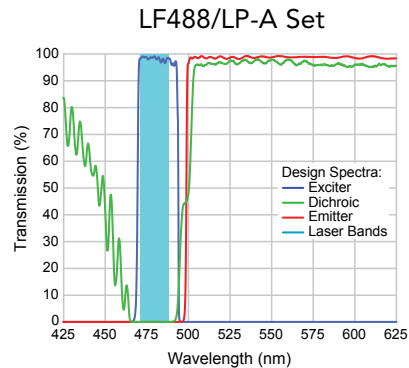
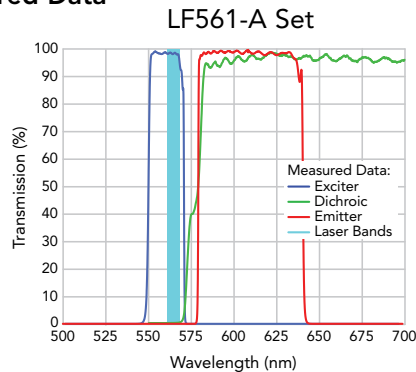
## Summary of compatible lasers and prominent fluorophores

Prominent Laser Line / Bands	Laser Description	Prominent Compatible Fluorophore(s)	Filter Set
375 ± 3 nm 405 ± 5 nm	GaN diode GaN diode	DAPI, BFP	LF405-A or LF405/LP-A
473 ± 2 nm 488 +3/-2 nm 491 nm	Doubled DPSS <sup>[1]</sup> , Diode Ar-ion gas, Doubled OPS <sup>[2]</sup> Doubled DPSS <sup>[1]</sup>	FITC, GFP	LF488-A or LF488/LP-A
559 ± 5 nm 561.4 nm 568.2 nm	Diode Doubled DPSS <sup>[1]</sup> Kr-ion gas	RFP's (mCherry, HcRed, DsRed), Texas Red®, TRITC, and Cy3™	LF651-A or LF561/LP-A
632.8 nm 635 +7/-0 nm 647.1 nm	HeNe gas AlGaInP diode, Kr-ion gas	Cy5™	LF635-A

[1] DPSS = Diode-pumped solid-state laser

[2] OPS = Optically pumped semiconductor laser

## Actual Measured Data



# BrightLine® Laser Fluorescence Single-band Sets

Extensive selection.  
30-day return policy.

**These items ship same day!**

Set / Primary Laser Wavelengths		Center Wavelength / Nominal Edge Wavelength	Avg Transmission / Bandwidth	Filter / Set Part Numbers
<b>LF405/LP-A</b> 375 & 405 nm <i>Long-pass set</i>	Exciter	390 nm	> 93% over 40 nm	FF01-390/40-25
	Emitter	418 nm (edge)	> 93% 421.5 – 900 nm	BLP01-405R-25
	Dichroic	415 nm (edge)	R <sub>abs</sub> > 94% 372 – 410 nm T <sub>avg</sub> > 93% 420 – 900 nm	Di01-R405-25x36
	<b>Unmounted Full Set:</b>			
<b>LF405-A</b> 375 & 405 nm <i>Bandpass set</i>	Exciter	390 nm	> 93% over 40 nm	FF01-390/40-25
	Emitter	452 nm	> 93% over 45 nm	FF01-452/45-25
	Dichroic	415 nm (edge)	R <sub>abs</sub> > 94% 372 – 410 nm T <sub>avg</sub> > 93% 420 – 900 nm	Di01-R405-25x36
	<b>Unmounted Full Set:</b>			
<b>LF488/LP-A</b> 473 & 488 nm <i>Long-pass set</i>	Exciter	482 nm	> 93% over 18 nm	FF01-482/18-25
	Emitter	500 nm (edge)	> 93% 504.7 – 900 nm	BLP01-488R-25
	Dichroic	497 nm (edge)	R <sub>abs</sub> > 94% 471 – 491 nm T <sub>avg</sub> > 93% 503 – 900 nm	Di01-R488-25x36
	<b>Unmounted Full Set:</b>			
<b>LF488-A</b> 473 & 488 nm <i>Bandpass set</i>	Exciter	482 nm	> 93% over 18 nm	FF01-482/18-25
	Emitter	525 nm	> 93% over 45 nm	FF01-525/45-25
	Dichroic	497 nm (edge)	R <sub>abs</sub> > 94% 471 – 491 nm T <sub>avg</sub> > 93% 503 – 900 nm	Di01-R488-25x36
	<b>Unmounted Full Set:</b>			
<b>LF561/LP-A</b> 559, 561.4, & 568.2 nm <i>Long-pass set</i>	Exciter	561 nm	> 93% over 14 nm	FF01-561/14-25
	Emitter	580 nm (edge)	> 93% 583.9 – 900 nm	BLP01-561R-25
	Dichroic	575 nm (edge)	R <sub>abs</sub> > 94% 554 – 568 nm T <sub>avg</sub> > 93% 582 – 1200 nm	Di01-R561-25x36
	<b>Unmounted Full Set</b>			
<b>LF561-A</b> 559, 561.4, & 568.2 nm <i>Bandpass set</i>	Exciter	561 nm	> 93% over 14 nm	FF01-561/14-25
	Emitter	609 nm	> 93% over 54 nm	FF01-609/54-25
	Dichroic	575 nm (edge)	R <sub>abs</sub> > 94% 554 – 568 nm T <sub>avg</sub> > 93% 582 – 1200 nm	Di01-R561-25x36
	<b>Unmounted Full Set</b>			
<b>LF635-A</b> 632.8, 635, & 647.1 nm <i>Bandpass set</i>	Exciter	640 nm	> 93% over 14 nm	FF01-640/14-25
	Emitter	676 nm	> 90% over 29 nm	FF01-676/29-25
	Dichroic	654 nm (edge)	R <sub>abs</sub> > 94% 632 – 647 nm T <sub>avg</sub> > 93% 663 – 1200 nm	Di01-R635-25x36
	<b>Unmounted Full Set</b>			



Filter Specifications on page 34

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# APPLICATION NOTE

## Crosstalk in FISH and Densely Multiplexed Imaging

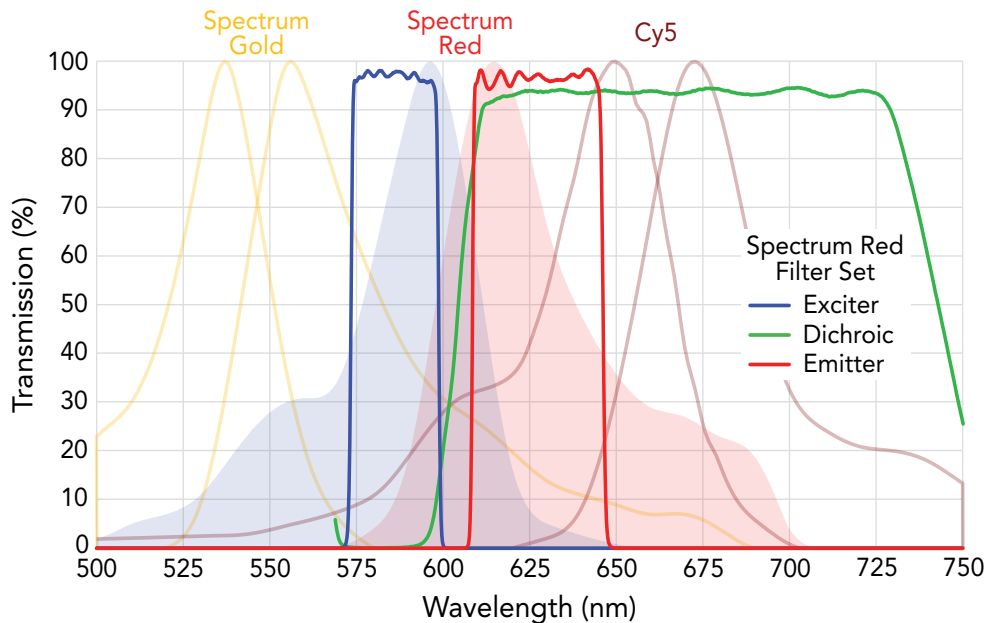
When using multiple, densely spaced fluorophores, rapid and accurate results rely on the ability to readily distinguish the fluorescence labels from one another. This dense multiplexing of images is particularly important when doing Fluorescence in Situ Hybridization (FISH) measurements. Thus it is critical to minimize crosstalk, or the signal from an undesired fluorophore relative to that of a desired fluorophore. The table below quantifies crosstalk values for neighboring fluorophores when using a given BrightLine FISH filter set. Values are determined from the overlap of typical, normalized fluorophore spectra, the filter design spectra, and an intense metal halide lamp.

Fluorophore		Relative Fluorophore Contributions for Each Filter Set								
Filter Set	DAPI	SpAqua	SpGreen	SpGold	SpOrange	SpRed	Cy5 / FRed	Cy5.5	Cy7	
DAPI	100%	30%	0%							
SpAqua	0%	100%	1%	0%						
SpGreen	0%	0%	100%	3%	0%					
SpGold		0%	2%	100%	49%	1%				
SpOrange			0%	36%	100%	11%	0%			
SpRed				0%	15%	100%	1%	0%		
Cy5 / FRed					0%	12%	100%	53%	1%	
Cy5.5						0%	53%	100%	6%	
Cy7								12%	100%	

As an example, when imaging a sample labeled with the SpectrumGreen™, SpectrumGold™, and SpectrumRed™ fluorophores using the SpectrumGold filter set, the undesired SpectrumGreen signal will be less than 2% of the desired SpectrumGold signal, and the SpectrumRed signal will be less than 1%.

## Amazing Spectra for Minimizing Crosstalk

These BrightLine filter sets are meticulously optimized to maximize brightness for popular fluorophores, while simultaneously minimizing unnecessary background as well as crosstalk with adjacent fluorophores. The graph below shows an example of the filter spectra for the SpectrumRed filter set (blue, green, and red solid lines), as well as the absorption and emission curves for SpectrumGold, SpectrumRed, and Cy5™ (left to right). Crosstalk is kept to only a few percent or less, as quantified in the table above.





# BrightLine® Single-band Sets for FISH & Dense Multiplexing

Extensive selection.  
30-day return policy.



PathVysion® assay control sample with CEP 17 and HER-2/neu probes (100X oil-immersion objective).

## Help ease the upstream battle against cancer with BrightLine FISH fluorescence filter sets.

Fluorescence In Situ Hybridization, or FISH, is an exciting fluorescence imaging technique that enables clinical-scale genetic screening based on molecular diagnostics. Semrock pioneered hard-coated BrightLine filters that are significantly brighter than and have superior contrast to older, soft-coated fluorescence filters, thus offering faster and more accurate measurements. Independent evaluations have shown that FISH images can be obtained in as little as one half the exposure time using BrightLine filters! And yet the inherent manufacturability of Semrock's patented ion-beam-sputtered filters actually allows them to be priced lower than soft-coated FISH filter sets.

Switching to BrightLine filters is the simplest and least expensive way to dramatically increase the quality of your FISH images!

## Full Spectrum of Solutions

Examples of popular assays using BrightLine FISH filter sets

Single-band Filter Sets	Assay	Purpose
■ ■ ■ DAPI, SpGr, SpOr	PathVysion®	Detects amplification of the HER-2 gene for screening and prognosis of breast cancer
■ ■ ■ ■ DAPI, SpAqua, SpGr, SpOr	AneuVysion®	Used as an aid in prenatal diagnosis of chromosomal abnormalities
■ ■ ■ ■ ■ DAPI, SpAqua, SpGr, SpGold, SpRed	UroVysion™	Aid for initial diagnosis of bladder carcinoma and subsequent monitoring for tumor recurrence in previously diagnosed patients
■ ■ ■ ■ ■ ■ DAPI, SpAqua, SpGr, SpGold, SpRed, Cy5	M-FISH	Permits the simultaneous visualization of all human (or mouse) chromosomes in different colors for karyotype analysis

## PRODUCT NOTE

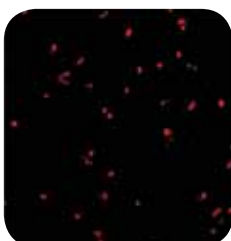
### Can better fluorescence filters really make a difference?

BrightLine "no-burn-out" filters have been tested widely in both research and clinical fields over many years of use. Extensive independent testing has also been performed with BrightLine FISH filter sets. A few examples of results are shown here. Whether you are finding and analyzing metaphase spreads or scoring cells by spot counting, significantly improve the speed and accuracy of your FISH analysis with BrightLine filter sets.

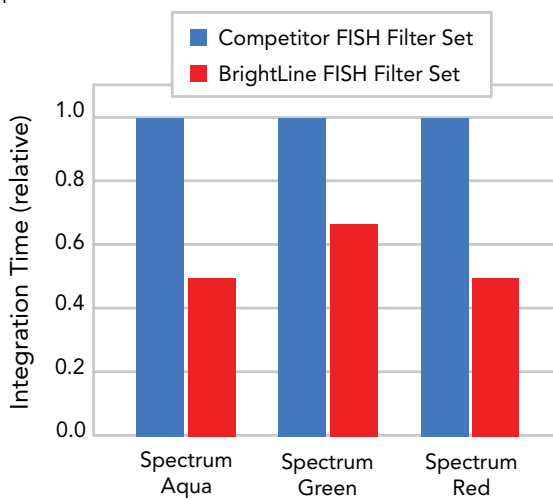
Competitor filter set



BrightLine filter set



Side-by-side independent comparison using equal exposure times of images achieved with competitor filter sets (left) and BrightLine filter sets (right), of a human tumor hybridized with CEP 3 probe in Spectrum Red (part of Vysis UroVysion™ assay, 400X magnification). Photo courtesy of Tina Bocker Edmonston, M.D., Thomas Jefferson University.



BrightLine filters allow shorter integration times for faster imaging – especially for automated tasks like metaphase finding. This independent industry test compares integration times required by BrightLine FISH filter sets to those of competitor filter sets. The automated system, based on a Zeiss Axio Imager microscope, found metaphase spreads with identical image intensities.

# BrightLine® Single-band Sets for FISH & Dense Multiplexing

Every Semrock filter is hard-coated for *no burn-out* performance.  
Five-year warranty.

**These items ship same day!**

Set / Primary Fluorophores		Center Wavelength / Nominal Edge Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>SpAqua-A</b> SpectrumAqua™, DEAC	Exciter	438 nm	> 93% over 24 nm	FF01-438/24-25
	Emitter	483 nm	> 93% over 32 nm	FF01-483/32-25
	Dichroic	458 nm (edge)	R <sub>avg</sub> > 98% 426 – 450 nm T <sub>avg</sub> > 90% 467 – 600 nm	FF458-Di01-25x36
				<b>Unmounted Full Set:</b> SpAqua-A-000 <b>"ZERO Pixel Shift" Set:</b> SpAqua-A-000-ZERO
<b>SpGr-A</b> SpectrumGreen™, FITC, Alexa Fluor® 488	Exciter	494 nm	> 93% over 20 nm	FF01-494/20-25
	Emitter	527 nm	> 93% over 20 nm	FF01-527/20-25
	Dichroic	506 nm (edge)	R <sub>avg</sub> > 98% 446 – 499.5 nm T <sub>avg</sub> > 90% 513.5 – 725 nm	FF506-Di02-25x36
				<b>Unmounted Full Set:</b> SpGr-A-000 <b>"ZERO Pixel Shift" Set:</b> SpGr-A-000-ZERO
<b>SpGold-A</b> SpectrumGold™, Alexa Fluor® 546	Exciter	534 nm	> 93% over 20 nm	FF01-534/20-25
	Emitter	572 nm	> 93% over 28 nm	FF01-572/28-25
	Dichroic	552 nm (edge)	R <sub>avg</sub> > 98% 524 – 544 nm T <sub>avg</sub> > 90% 558 – 725 nm	FF552-Di01-25x36
				<b>Unmounted Full Set:</b> SpGold-A-000 <b>"ZERO Pixel Shift" Set:</b> SpGold-A-000-ZERO
<b>SpOr-A</b> SpectrumOrange™, Cy3™, Rhodamine, Alexa Fluor® 555	Exciter	543 nm	> 93% over 22 nm	FF01-543/22-25
	Emitter	586 nm	> 93% over 20 nm	FF01-586/20-25x3.5
	Dichroic	562 nm (edge)	R <sub>avg</sub> > 98% 499 – 554.5 nm T <sub>avg</sub> > 90% 569.5 – 730 nm	FF562-Di02-25x36
				<b>Unmounted Full Set:</b> SpOr-A-000 <b>"ZERO Pixel Shift" Set:</b> SpOr-A-000-ZERO
<b>SpRed-A</b> SpectrumRed™, Texas Red, Alexa Fluor® 647 & 660	Exciter	586 nm	> 93% over 20 nm	FF01-586/20-25x5
	Emitter	628 nm	> 93% over 32 nm	FF01-628/32-25
	Dichroic	605 nm (edge)	R <sub>avg</sub> > 98% 576 – 596 nm T <sub>avg</sub> > 90% 612 – 725 nm	FF605-Di01-25x36
				<b>Unmounted Full Set:</b> SpRed-A-000 <b>"ZERO Pixel Shift" Set:</b> SpRed-A-000-ZERO



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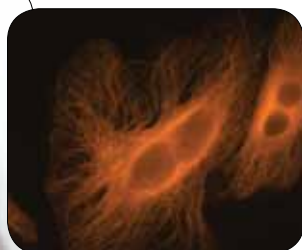
NOTE: For DAPI, Cy5™, Cy5.5™, or Cy7™ sets, refer to pages 9-11.

For FISH multiband combination filter sets, see [www.semrock.com](http://www.semrock.com) for a complete listing.

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# Qdot® Single-band Filter Sets

Extensive selection.  
30-day return policy.



Cell image courtesy of Invitrogen.

These single-band filter sets are specially optimized for brilliant, dense multi-color detection with Molecular Probes® (Invitrogen Detection Technologies) quantum dot nanocrystals. The highly transmitting, deep-blue exciter achieves maximum quantum dot excitation efficiency while virtually eliminating any DAPI or Hoechst excitation. And with the no burn-out reliability shared by all BrightLine filters, the permanent performance of these sets will outlast even your quantum dots!

**These items ship same day!**

Set / Primary Fluorophores		Center Wavelength / Nominal Edge Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>QDLP-A</b> Qdot® 525, 565, 585, 605, 625, 655, 705, & 800 Nanocrystals  <i>Versatile and high brightness long-pass filter set for viewing multiple Qdots</i>	Exciter	435 nm	> 90% over 40 nm	FF01-435/40-25
	Emitter	515 nm (edge)	> 90% 519 – 700 nm	FF01-500/LP-25
	Dichroic	510 nm (edge)	R <sub>avg</sub> > 98% 327 – 488 nm T <sub>avg</sub> > 90% 515 – 850 nm	FF510-Di01-25x36
	<b>Unmounted Full Set:</b>			<b>QDLP-A-000</b>
<b>QD525-A</b> Qdot® 525 Nanocrystals  <i>High brightness and contrast single-band filter set</i>	Exciter	435 nm	> 90% over 40 nm	FF01-435/40-25
	Emitter	525 nm	> 90% over 15 nm	FF01-525/15-25
	Dichroic	510 nm (edge)	R <sub>avg</sub> > 98% 327 – 488 nm T <sub>avg</sub> > 90% 515 – 850 nm	FF510-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>QD525-A-000</b> QD525-A-000-ZERO
<b>QD605-A</b> Qdot® 605 Nanocrystals  <i>High brightness and contrast single-band filter set</i>	Exciter	435 nm	> 90% over 40 nm	FF01-435/40-25
	Emitter	605 nm	> 90% over 15 nm	FF01-605/15-25
	Dichroic	510 nm (edge)	R <sub>avg</sub> > 98% 327 – 488 nm T <sub>avg</sub> > 90% 515 – 850 nm	FF510-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>QD605-A-000</b> QD605-A-000-ZERO
<b>QD625-A</b> Qdot® 625 Nanocrystals  <i>High brightness and contrast single-band filter set</i>	Exciter	435 nm	> 90% over 40 nm	FF01-435/40-25
	Emitter	625 nm	> 90% over 15 nm	FF01-625/15-25
	Dichroic	510 nm (edge)	R <sub>avg</sub> > 98% 327 – 488 nm T <sub>avg</sub> > 90% 515 – 850 nm	FF510-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>QD625-A-000</b> QD625-A-000-ZERO
<b>QD655-A</b> Qdot® 655 Nanocrystals  <i>High brightness and contrast single-band filter set</i>	Exciter	435 nm	> 90% over 40 nm	FF01-435/40-25
	Emitter	655 nm	> 90% over 15 nm	FF01-655/15-25
	Dichroic	510 nm (edge)	R <sub>avg</sub> > 98% 327 – 488 nm T <sub>avg</sub> > 90% 515 – 850 nm	FF510-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			<b>QD655-A-000</b> QD655-A-000-ZERO



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See spectra graphs and ASCII data for all of our filters at  
[www.semrock.com](http://www.semrock.com)

## TECHNICAL NOTE

### Fluorescence Imaging with Quantum Dot Nanocrystals

Quantum dot nanocrystals are fluorophores in that they absorb photons of light and then re-emit longer-wavelength photons nearly instantaneously. However, there are some important differences between quantum dots (e.g., Qdot® nanocrystals made by Invitrogen Molecular Probes®) and traditional fluorophores including organic dyes and naturally fluorescing proteins. Quantum dots are nanometer-scale clusters of semiconductor atoms, typically coated with an additional semiconductor shell and then a polymer coating to enable coupling to proteins, oligonucleotides, small molecules, etc., which are then used for direct binding of the quantum dots to targets of interest.

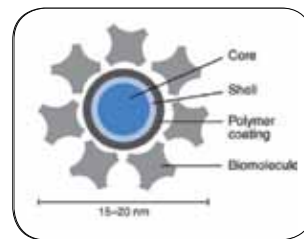
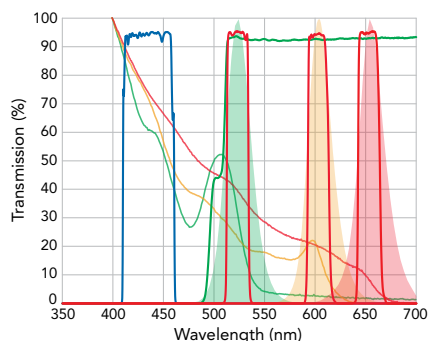


Figure 1. Structure of a nanocrystal.

Nanocrystals are extremely bright and highly photostable, making them ideal for applications that require high sensitivity with minimal label interference, as well as long-term photostability, such as live-cell imaging and dynamic studies. Their excellent photostability also means they are fixable and archivable for permanent sample storage in pathology applications, for example. Because there is a direct relationship between the size of a nanocrystal and the wavelength of the emitted fluorescence, a full range of nanocrystals can be made – each with a narrow, distinct emission spectrum and all excited by a single blue or ultraviolet wavelength. Thus nanocrystals are ideal for dense multiplexing. Some important nanocrystal features that may limit certain applications include their fairly large physical size and long lifetime.



To take advantage of nanocrystal features, it is important to use properly optimized filters. Semrock offers BrightLine® filter sets specially optimized for the most popular quantum dot imaging applications. A universal set with a long-wave-pass emitter enables simultaneous imaging of multiple quantum dots by eye or with a color camera. Additionally, filter sets tailored to individual quantum dots are also available (see page 17). Best of all, these filters share the incredible “no burn-out” reliability of all BrightLine filters, an ideal match for highly photostable quantum dot nanocrystals!

Figure 2. A universal exciter provides superior excitation efficiency while avoiding the excitation of DAPI and undesirable autofluorescence. This filter is combined with a dichroic beamsplitter with extremely wide reflection and transmission bands for maximum flexibility, and narrow, highly transmitting emission filters matched to each of the most important Qdot wavelengths.

## TECHNICAL NOTE

### Ultraviolet (UV) Fluorescence Applications

Many biological molecules of interest naturally fluoresce when excited by shorter wavelength UV light. This “intrinsic fluorescence” can be a powerful tool as labeling with extrinsic fluorophores is not required. One important application is the direct fluorescence imaging of aromatic amino acids including tryptophan, tyrosine, and phenylalanine, which are building blocks for proteins. The aromatic rings in these molecules give rise to strong fluorescence excitation peaks in the 260 to 280 nm range. Another application is DNA quantitation. Purines and pyrimidines – bases for nucleic acids like DNA and RNA – have strong absorption bands in the 260 to 280 nm range.

Semrock’s UV BrightLine fluorescence filters offer a powerful tool for direct fluorescence imaging. These unique UV filters are reliable (no burn-out) and offer performance nearly comparable to visible and near-IR filters. Figure 1 shows the spectrum of a high-reliability 280 nm BrightLine excitation filter with the highest commercially available transmission (> 65%), remarkably steep edges, and wideband blocking across the entire UV and visible spectrum. This spectrum is directly compared to a traditional and inferior metal-dielectric filter. In one example system, this filter difference was shown to provide over 100x improvement in signal-to-noise ratio.

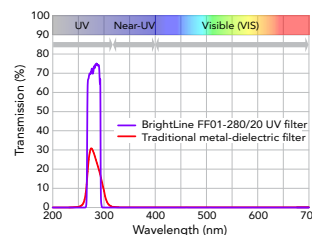


Figure 1. BrightLine FF01-280/20-25 filter

Figure 2 shows the spectra from a UV filter set designed for imaging tryptophan, overlaid on the absorption and emission spectra for that amino acid. Note the nearly ideal overlap and high transmission of all three filters in this set.

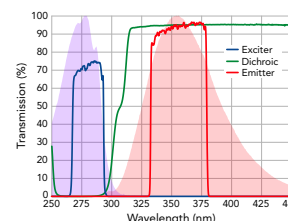


Figure 2. TRP-A single-band fluorescence filter set is ideal for imaging tryptophan (see page 9).

# BrightLine® FRET Single-band Sets

Extensive selection.  
30-day return policy.

These filter sets offer our simplest solution for dual-wavelength FRET imaging. Also see our multiband "Sedat" filter sets for high-performance FRET imaging starting on page 28.

**These items ship same day!**

Set / Primary Fluorophores		Center Wavelength / Nominal Edge Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>FRET-BFP/GFP-A</b>  Blue: BFP, DAPI, Hoechst, Alexa Fluor® 350 Green: GFP, EGFP, FITC, Cy2™, Alexa Fluor® 488	Exciter	387 nm	> 90% over 11 nm	FF01-387/11-25
	Emitter 1	447 nm	> 93% over 60 nm	FF02-447/60-25
	Emitter 2	520 nm	> 93% over 35 nm	FF01-520/35-25
	Dichroic	409 nm (edge)	R <sub>avg</sub> > 98% 344 – 404 nm T <sub>avg</sub> > 90% 415 – 570 nm	FF409-Di02-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			
<b>FRET-CFP/YFP-A</b>  Cyan: CFP, CyPet, AmCyan Yellow: YFP, YPet, Venus	Exciter	438 nm	> 93% over 24 nm	FF01-438/24-25
	Emitter 1	483 nm	> 93% over 32 nm	FF01-483/32-25
	Emitter 2	542 nm	> 93% over 27 nm	FF01-542/27-25
	Dichroic	458 nm (edge)	R <sub>avg</sub> > 98% 426 – 450 nm T <sub>avg</sub> > 90% 467 – 600 nm	FF458-Di01-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			
<b>FRET-GFP/RFP-A</b>  Green: GFP, EGFP, FITC, Cy2™, Alexa Fluor® 488 Red: mCherry, mStrawberry, dTomato, DsRed, TRITC, Cy3™	Exciter	472 nm	> 93% over 30 nm	FF01-472/30-25
	Emitter 1	520 nm	> 93% over 35 nm	FF01-520/35-25
	Emitter 2	607 nm	> 93% over 36 nm	FF01-607/36-25
	Dichroic	495 nm (edge)	R <sub>avg</sub> > 98% 442 – 488 nm T <sub>avg</sub> > 90% 502 – 730 nm	FF495-Di02-25x36
	<b>Unmounted Full Set:</b> "ZERO Pixel Shift" Set:			



Filter Specifications on page 34

## TECHNICAL NOTE

### Fluorescence Resonance Energy Transfer (FRET)

Fluorescence Resonance Energy Transfer (FRET) is a powerful technique for characterizing distance-dependent interactions on a molecular scale. FRET starts with the excitation of a donor fluorophore molecule by incident light within its absorption spectrum. If another fluorophore molecule (the acceptor) is in close proximity to the donor and has an absorption spectrum that overlaps the donor emission spectrum, nonradiative energy transfer may occur between donor and acceptor. For example, CFP and YFP support a strong FRET interaction. FRET can measure distances on the order of the "Förster distance" – typically 20 to 90 Å. This length scale is far below the Rayleigh-criterion resolution limit of an optical microscope (about 2500 Å for visible light and high numerical aperture), thus illustrating the power of FRET for measuring extremely small distance interactions.

A simple approach for observing FRET requires merely an exciter and a dichroic beamsplitter for the donor fluorophore, and some means for exchanging emitters optimized for the donor and acceptor fluorophores. Figure 1 shows CFP absorption and emission spectra and the transmission spectra for three of the four filters from the FRET-CFP/YFP-A set (for quantifying the fluorescence from the CFP donor). Figure 2 shows the YFP emission spectrum and spectra for the same exciter and dichroic, but with the YFP emitter for quantifying the fluorescence from the YFP acceptor. For the highest performance and flexibility, a multiband beamsplitter with single-band exciter and emitter filters may be used in a microscope equipped with dual, synchronized filter wheels. Our multiband "Sedat" filter sets, such as the CFP/YFP-2X2M-A set, are ideal for this approach – see page 28.

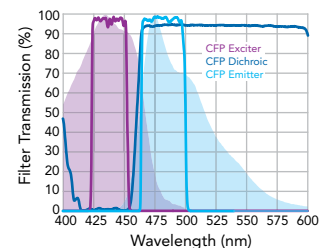


Figure 1: CFP exciter, dichroic, and emitter filters (from FRET-CFP/YFP-A set) for measuring donor emission.

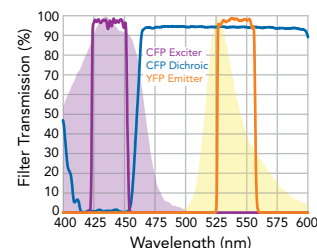


Figure 2: CFP exciter and dichroic filters with YFP emitter filter (from FRET-CFP/YFP-A set) for measuring acceptor emission.

## BrightLine Basic™ Best-value Single-band Sets

Every Semrock filter is hard-coated for *no burn-out* performance. Five-year warranty.

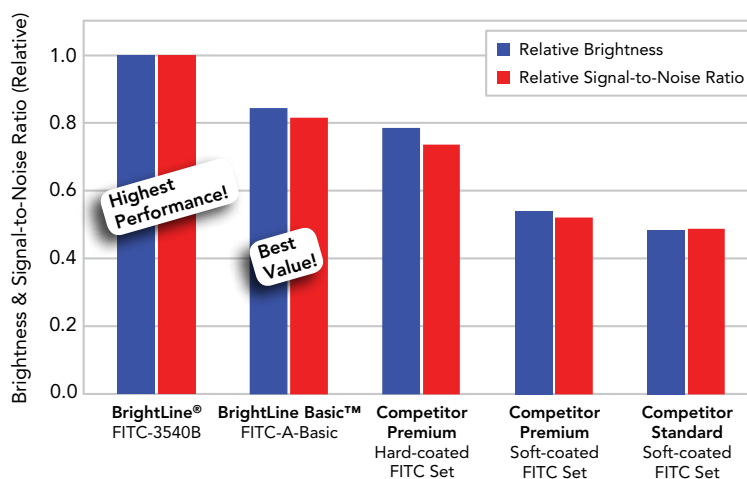


### How can you do great research on a tight budget? BrightLine Basic™ fluorescence filter sets!

These value-priced single-band filter sets combine the proven durability of BrightLine® research sets with optical performance that exceeds premium soft-coated fluorescence filters, yet are offered at soft-coated prices. In fact, BrightLine Basic filter sets are brighter than soft-coated filter sets of comparable contrast, but don't burn out, further lowering the total cost of ownership. Ideal for routine applications that require cost-effective, high volume capabilities and no burn-out such as: clinical microscopy (mycological and fungal staining, immunofluorescent testing), routine analysis, and education.

### Hard-coated performance at soft-coated prices™

Measured data taken on an Olympus BX microscope using a 40X objective and a QImaging Retiga camera. Sample is Invitrogen / Molecular Probes FluoCells #2 sample (BODIPY FL fluorophore).



### BrightLine (Highest Performance) set compared to BrightLine Basic (Best value) set

Semrock's highest-performance BrightLine filter sets offer the best fluorescence filters available, while the value-priced BrightLine Basic filter sets provide a high level of performance and same proven durability at an outstanding price.

BrightLine Filter Set	BrightLine Basic Filter Set	BrightLine Filter Set Compared to BrightLine Basic Filter Set*
\$645	\$495	
DAPI-1160A	BFP-A-Basic	>10% higher brightness; >10% higher contrast (using BFP)
DAPI-5060B		Several times brighter; comparable contrast (using BFP)
CFP-2432A	CFP-A-Basic	Tens of percent higher brightness; comparable contrast
GFP-3035B	GFP-A-Basic	Tens of percent higher contrast; brightness slightly lower
FITC-3540B	FITC-A-Basic	>10% higher brightness; >10% higher contrast
YFP-2427A	YFP-A-Basic	Tens of percent higher brightness; comparable contrast
TRITC-A	TRITC-A-Basic	Tens of percent higher brightness and contrast; Basic set intentionally designed for traditional deep-red TRITC emission
TXRED-4040B	TXRED-A-Basic	>10% higher brightness; >10% higher contrast

- Only sets which have corresponding BrightLine and BrightLine Basic sets are listed.
- Brightness is based on relative throughput using the primary fluorophore and assuming typical metal-halide lamp and CCD camera spectral responses.
- Contrast is the signal-to-noise ratio (SNR), assuming the background noise is dominated by broadband autofluorescence (as is typically the case in moderate to higher fluorophore concentration samples).

\* Actual results may vary depending on instrumentation and the exact sample preparation, which can substantially impact the spectra and relative intensities of the fluorophore and background.

# BrightLine Basic™ Best-value Single-band Sets

Extensive selection.  
30-day return policy.

**These items ship same day!**

Set / Primary Fluorophores		Center Wavelength / Nominal Edge Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>CFW-LP01-Clinical</b>  Calcofluor White, DAPI  <i>Long-pass set</i> <i>Mycological and fungal staining tests</i>	Exciter	387 nm	> 90% over 11 nm	<b>Sold as set only</b>
	Emitter	416 nm (edge)	> 90% 419 – 700 nm	
	Dichroic	412 nm (edge)	R <sub>avg</sub> > 90% 362 – 396 nm T <sub>avg</sub> > 90% 419 – 700 nm	
	<b>Unmounted Full Set:</b>			
<b>CFW-BP01-Clinical</b>  Calcofluor White, DAPI  <i>Mycological and fungal staining tests</i>	Exciter	387 nm	> 90% over 11 nm	<b>Sold as set only</b>
	Emitter	442 nm	> 90% over 46 nm	
	Dichroic	412 nm (edge)	R <sub>avg</sub> > 90% 362 – 396 nm T <sub>avg</sub> > 90% 419 – 700 nm	
	<b>Unmounted Full Set:</b>			
<b>BFP-A-Basic</b>  BFP, DAPI, Hoechst, AMCA, Alexa Fluor® 350	Exciter	390 nm	> 90% over 18 nm	FF01-390/18-25
	Emitter	460 nm	> 90% over 60 nm	FF01-460/60-25
	Dichroic	416 nm (edge)	R <sub>avg</sub> > 90% 360 – 407 nm T <sub>avg</sub> > 90% 425 – 575 nm	FF416-Di01-25x36
	<b>Unmounted Full Set:</b>			
<b>CFP-A-Basic</b>  CFP, AmCyan, SYTOX Blue, BOBO-1, BO-PRO-1	Exciter	434 nm	> 90% over 17 nm	FF01-434/17-25
	Emitter	479 nm	> 90% over 40 nm	FF01-479/40-25
	Dichroic	452 nm (edge)	R <sub>avg</sub> > 90% 423 – 445 nm T <sub>avg</sub> > 90% 460 – 610 nm	FF452-Di01-25x36
	<b>Unmounted Full Set:</b>			
<b>WGFP-A-Basic</b>  wtGFP	Exciter	445 nm	> 90% over 45 nm	FF01-445/45-25
	Emitter	510 nm	> 90% over 42 nm	FF01-510/42-25
	Dichroic	482 nm (edge)	R <sub>avg</sub> > 90% 415 – 470 nm T <sub>avg</sub> > 90% 490 – 720 nm	FF482-Di01-25x36
	<b>Unmounted Full Set:</b>			
<b>GFP-A-Basic</b>  GFP, EGFP, DiO, Cy2™, YOYO-1, YO-PRO-1	Exciter	469 nm	> 90% over 35 nm	FF01-469/35-25
	Emitter	525 nm	> 90% over 39 nm	FF01-525/39-25
	Dichroic	497 nm (edge)	R <sub>avg</sub> > 90% 452 – 490 nm T <sub>avg</sub> > 90% 505 – 800 nm	FF497-Di01-25x35
	<b>Unmounted Full Set:</b>			
<b>FITC-A-Basic</b>  FITC, rsGFP, Bodipy, FAM, Fluo-4, Alexa Fluor® 488	Exciter	475 nm	> 90% over 35 nm	FF01-475/35-25
	Emitter	530 nm	> 90% over 43 nm	FF01-530/43-25
	Dichroic	499 nm (edge)	R <sub>avg</sub> > 90% 470 – 490 nm T <sub>avg</sub> > 90% 508 – 675 nm	FF499-Di01-25x36
	<b>Unmounted Full Set:</b>			



(continued) Filter Specifications on page 34

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# BrightLine Basic™ Best-value Single-band Sets

Every Semrock filter is hard-coated for *no burn-out* performance.  
Five-year warranty.

**These items ship same day!**

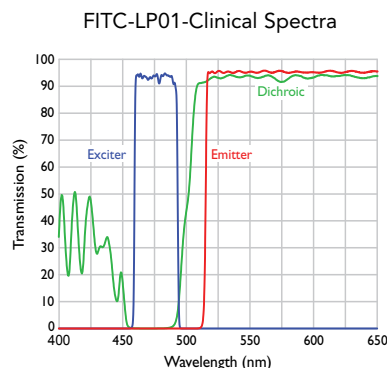
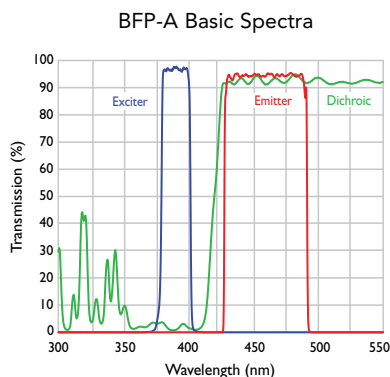
Set / Primary Fluorophores		Center Wavelength / Nominal Edge Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>FITC-LP01-Clinical</b> FITC, Acridine Orange <i>Long-pass set</i> <i>Immunofluorescent clinical tests</i>	Exciter	475 nm	> 90% over 28 nm	<b>Sold as set only</b>
	Emitter	515 nm (edge)	> 90% 519 - 700 nm	
	Dichroic	502 nm (edge)	R <sub>avg</sub> > 90% 461.5 - 489.5 nm T <sub>avg</sub> > 90% 519 - 700 nm	
<b>Unmounted Full Set:</b>				<b>FITC-LP01-Clinical-000</b>
<b>YFP-A-Basic</b> YFP, Calcium Green-1, Eosin, Fluo-3, Rhodamine 123	Exciter	497 nm	> 90% over 16 nm	FF01-497/16-25
	Emitter	535 nm	> 90% over 22 nm	FF01-535/22-25
	Dichroic	516 nm (edge)	R <sub>avg</sub> > 90% 490 - 510 nm T <sub>avg</sub> > 90% 520 - 700 nm	FF516-Di01-25x36
<b>Unmounted Full Set:</b>				<b>YFP-A-Basic-000</b>
<b>TRITC-A-Basic</b> TRITC, Rhodamine, Dil, 5-TAMRA, Alexa Fluor® 532 & 546	Exciter	542 nm	> 90% over 20 nm	FF01-542/20-25
	Emitter	620 nm	> 90% over 52 nm	FF01-620/52-25
	Dichroic	570 nm (edge)	R <sub>avg</sub> > 90% 525 - 556 nm T <sub>avg</sub> > 90% 580 - 650 nm	FF570-Di01-25x36
<b>Unmounted Full Set:</b>				<b>TRITC-A-Basic-000</b>
<b>CY3.5-A-Basic</b> Cy3.5™, mStrawberry	Exciter	565 nm	> 90% over 24 nm	FF01-565/24-25
	Emitter	620 nm	> 90% over 52 nm	FF01-620/52-25
	Dichroic	585 nm (edge)	R <sub>avg</sub> > 90% 533 - 580 nm T <sub>avg</sub> > 90% 595 - 800 nm	FF585-Di01-25x36
<b>Unmounted Full Set:</b>				<b>CY3.5-A-Basic-000</b>
<b>TXRED-A-Basic</b> Texas Red®, mCherry, 5-ROX, Alexa Fluor® 568 & 594	Exciter	559 nm	> 90% over 34 nm	FF01-559/34-25
	Emitter	630 nm	> 90% over 69 nm	FF01-630/69-25
	Dichroic	585 nm (edge)	R <sub>avg</sub> > 90% 533 - 580 nm T <sub>avg</sub> > 90% 595 - 800 nm	FF585-Di01-25x36
<b>Unmounted Full Set:</b>				<b>TXRED-A-Basic-000</b>



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See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)



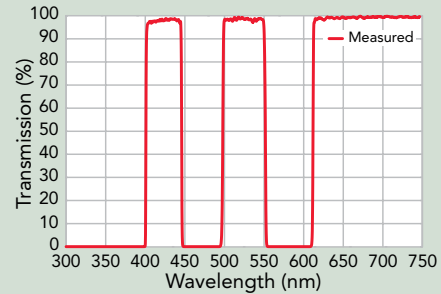


# BrightLine® Multiband Fluorescence Sets

Extensive selection.  
30-day return policy.

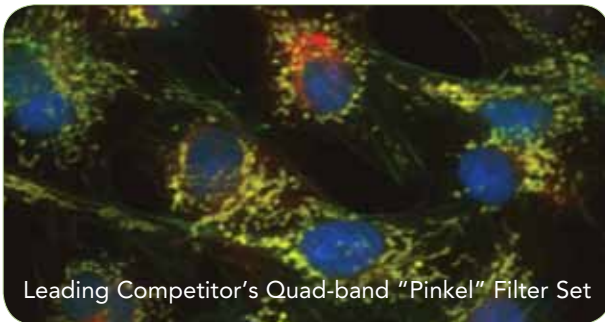
Semrock manufactures multiband fluorescence filters with passband, edge steepness, and blocking performance that rival the best single-band filters, and all with the superior, “no burn-out” durability of hard coatings. In fact, every filter in every BrightLine filter set, including these multiband sets, is made with the same, durable hard-coating technology. So you will always see...

- ▶ The highest transmission and steepest edges for dazzling brightness – visually and digitally
- ▶ Deep blocking for striking contrast – visually and digitally
- ▶ ALL hard dielectric coatings, including blue and UV filters, for long-lasting “no burn-out” performance

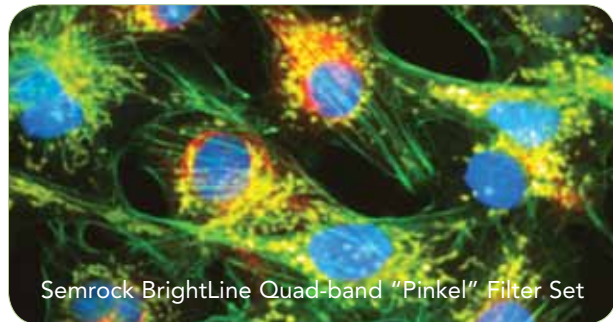


Graph above shows typical measured transmission of the FF01-425/527/685-25 filter

## Independent test findings – four times brighter and twice the contrast

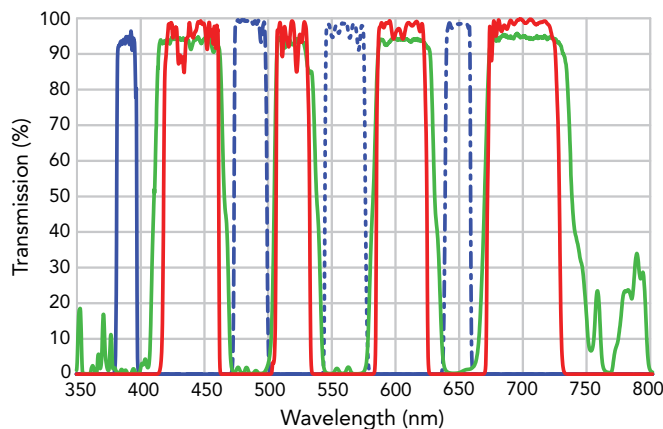


Leading Competitor's Quad-band "Pinkel" Filter Set



Semrock BrightLine Quad-band "Pinkel" Filter Set

Comparisons done under identical imaging conditions using an Olympus BX61WI microscope outfitted with DSU spinning-disk confocal unit and Hamamatsu ORCA-ER monochrome CCD camera. Sample of Rat Kidney Mesangial Cells courtesy of Mike Davidson, Molecular Expressions™, using: Hoechst 33258, Alexa Fluor® 488 – Phalloidin, MitoTracker Red CMXRos, and Vimentin (Ms) – Cy5™. Semrock DA/FI/TR/Cy5-4X-A filter set (see page 27).



DA/FI/TR/Cy5-4X-A "Pinkel" Set Spectra

This 6-filter quad-band set is designed for high-speed, sequential imaging of DAPI, FITC, TRITC, and Cy5. The complete set is comprised of a quad-band beamsplitter with one quadband emitter and four “no burn-out” single-band exciters. The single-band filters are intended to be mounted in filter wheels. For a “Sedat” version of this filter set, see the DA/FI/TR/Cy5-4X4M-B set on page 29.

# BrightLine® Multiband Fluorescence Sets

Every Semrock filter is hard-coated for *no burn-out* performance. Five-year warranty.

“Full Multiband” Dual-band Filter Sets – multiband exciters, emitters and beamsplitters (See page 31 for Technical Note)

**These items ship same day!**

Set / Primary Fluorophores	Center Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>DA/FI-A Full Multiband Set</b>  Blue: DAPI, Hoechst, AMCA, BFP, Alexa Fluor® 350 Green: FITC, GFP, rsGFP, Bodipy, Alexa Fluor® 488	387 nm 480 nm	> 80% over 11 nm > 90% over 29 nm	Dual-band Exciter FF01-387/480-25
	433 nm 530 nm	> 90% over 38 nm > 90% over 40 nm	Dual-band Emitter FF01-433/530-25
	<b>Avg. Reflection / Bandwidths</b> <b>Avg. Transmission / Bandwidth</b>		
	> 97.5% 370 – 393 nm > 97.5% 466 – 495 nm	> 90% 414 – 452 nm > 90% 510 – 550 nm	Dual-band Dichroic FF403/502-Di01-25x36
<b>Unmounted Full Set:</b>			<b>DA/FI-A-000</b>
<b>CFP/YFP-A Full Multiband Set</b>  Cyan: CFP, AmCyan, SYTOX Blue, BOBO-1, BO-PRO-1 Yellow: YFP, Calcium Green-1, Eosin, Rhodamine 123	416 nm 501 nm	> 90% over 25 nm > 90% over 18 nm	Dual-band Exciter FF01-416/501-25
	464 nm 547 nm	> 90% over 23 nm > 90% over 31 nm	Dual-band Emitter FF01-464/547-25
	<b>Avg. Reflection / Bandwidths</b> <b>Avg. Transmission / Bandwidth</b>		
	> 95% 415 – 432 nm > 95% 493 – 511 nm	> 90% 449 – 483 nm > 90% 530 – 569 nm	Dual-band Dichroic FF440/520-Di01-25x36
<b>Unmounted Full Set:</b>			<b>CFP/YFP-A-000</b>
<b>GFP/DsRed-A Full Multiband Set</b>  Green: GFP, rsGFP, FITC, Alexa Fluor® 488 Red: DsRed, TRITC, Cy3™, Texas Red®, Alexa Fluor® 568 & 594	468 nm 553 nm	> 90% over 34 nm > 90% over 24 nm	Dual-band Exciter FF01-468/553-25
	512 nm 630 nm	> 90% over 23 nm > 90% over 91 nm	Dual-band Emitter FF01-512/630-25
	<b>Avg. Reflection / Bandwidths</b> <b>Avg. Transmission / Bandwidth</b>		
	> 95% 456 – 480 nm > 95% 541 – 565 nm	> 90% 500 – 529 nm > 90% 584 – 679 nm	Dual-band Dichroic FF493/574-Di01-25x36
<b>Unmounted Full Set:</b>			<b>GFP/DsRed-A-000</b>
<b>FITC/TxRed-A Full Multiband Set</b>  Green: FITC, GFP, rsGFP, Bodipy, Alexa Fluor® 488 Red: Texas Red®, mCherry, Alexa Fluor® 568 & 594	479 nm 585 nm	> 90% over 38 nm > 90% over 27 nm	Dual-band Exciter FF01-479/585-25
	524 nm 628 nm	> 90% over 29 nm > 90% over 33 nm	Dual-band Emitter FF01-524/628-25
	<b>Avg. Reflection / Bandwidths</b> <b>Avg. Transmission / Bandwidth</b>		
	> 95% 458 – 499 nm > 95% 570 – 600 nm	> 90% 509 – 541 nm > 90% 612 – 647 nm	Dual-band Dichroic FF505/606-Di01-25x36
<b>Unmounted Full Set:</b>			<b>FITC/TxRed-A-000</b>
<b>Cy3/Cy5-A Full Multiband Set</b>  Yellow: Cy3™, DsRed, Alexa Fluor® 555 Red: Cy5™, SpectrumFRed™, Alexa Fluor® 647 & 660	534 nm 635 nm	> 90% over 36 nm > 90% over 31 nm	Dual-band Exciter FF01-534/635-25
	577 nm 690 nm	> 90% over 24 nm > 90% over 50 nm	Dual-band Emitter FF01-577/690-25
	<b>Avg. Reflection / Bandwidths</b> <b>Avg. Transmission / Bandwidth</b>		
	> 95% 514 – 553 nm > 95% 617 – 652 nm	> 90% 564 – 591 nm > 90% 665 – 718 nm	Dual-band Dichroic FF560/659-Di01-25x36
<b>Unmounted Full Set:</b>			<b>Cy3/Cy5-A-000</b>

**New!**

Dual-band

Dual-band

Dual-band

Dual-band

Dual-band



(continued)

Filter Specifications on page 34

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# BrightLine® Multiband Fluorescence Sets

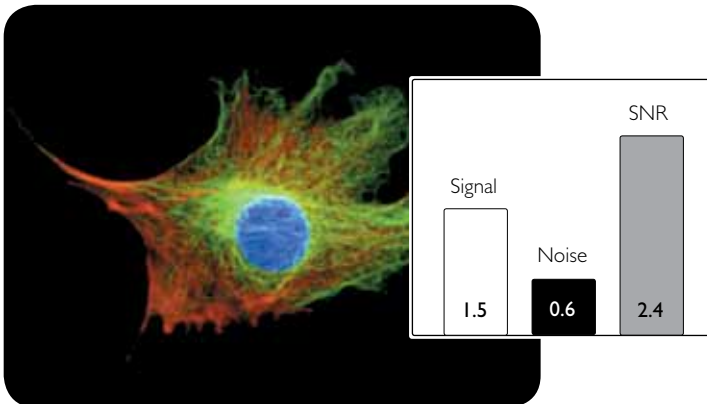
Extensive selection.  
30-day return policy.

## “Full Multiband” Triple-band Filter Sets (continued)

**These items ship same day!**

Set / Primary Fluorophores	Center Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>DA/FI/TR-A Full Multiband Set</b>  Blue: DAPI, Hoechst, AMCA, BFP, Alexa Fluor® 350 Green: FITC, GFP, rsGFP, Bodipy, Alexa Fluor® 488 Orange: TRITC (Tetramethylrhodamine), DsRed, Cy3™, Alexa Fluor® 555  <i>Triple-band</i>	387 nm 478 nm 555 nm	> 80% over 11 nm > 90% over 24 nm > 90% over 19 nm	Triple-band Exciter FF01-387/478/555-25
	432 nm 516 nm 614 nm	> 90% over 36 nm > 90% over 23 nm > 90% over 61 nm	Triple-band Emitter FF01-433/517/613-25
	<b>Avg. Reflection / Bandwidths</b>	<b>Avg. Transmission / Bandwidth</b>	
	> 97.5% 386 – 393 nm > 97.5% 466 – 490 nm > 97.5% 546 – 565 nm	> 90% 414 – 450 nm > 90% 505 – 528 nm > 90% 584 – 645 nm	Triple-band Dichroic FF403/497/574-Di01-25x36
<b>Unmounted Full Set:</b>			<b>DA/FI/TR-A-000</b>
<b>DA/FI/TX-B Full Multiband Set</b>  Blue: DAPI, Hoechst, AMCA, BFP, Alexa Fluor® 350 Green: FITC, GFP, rsGFP, Bodipy, Alexa Fluor® 488 Red: Texas Red®, MitoTracker Red, Alexa Fluor® 568 & 594  <i>Triple-band</i>	407 nm 494 nm 576 nm	> 80% over 14 nm > 85% over 20 nm > 85% over 20 nm	Triple-band Exciter FF01-407/494/576-25
	457 nm 530 nm 628 nm	> 80% over 22 nm > 85% over 20 nm > 85% over 28 nm	Triple-band Emitter FF01-457/530/628-25
	<b>Avg. Reflection / Bandwidths</b>	<b>Avg. Transmission / Bandwidth</b>	
	> 97.5% 394 – 414 nm > 97.5% 484 – 504 nm > 97.5% 566 – 586 nm	> 90% 446 – 468 nm > 90% 520 – 540 nm > 90% 614 – 642 nm	Triple-band Dichroic FF436/514/604-Di01-25x36
<b>Unmounted Full Set:</b>			<b>DA/FI/TX-B-000</b>

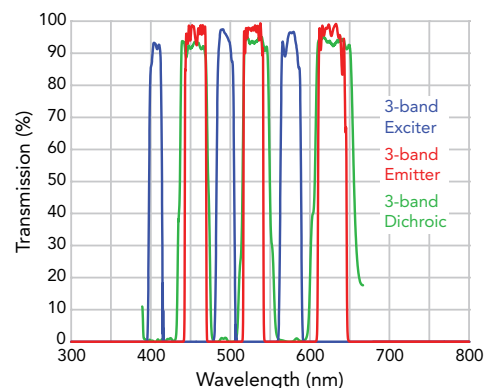
Filter Specifications on page 34



Semrock’s award-winning multiband filter sets are uniquely optimized to provide brilliant colors and a very black background. In this example, the relative signal, noise, and signal-to-noise ratio achieved by a BrightLine DA/FI/TX-B filter set was compared side-by-side with the performance of the comparably priced premium soft-coated Full Multiband set of a leading competitor. The BrightLine filters are 50% brighter and provide a stunning 2.4 times higher contrast.

The “full multiband” configuration uses all multiband filters – exciter, emitter, and dichroic beamsplitter – and is ideal for direct visualization, such as locating areas of interest on a sample. The DA/FI/TX-B filter set is shown above.

For graphs, ASCII data and full fluorophore list, go to [www.semrock.com](http://www.semrock.com)



# BrightLine® Multiband Fluorescence Sets

Every Semrock filter is hard-coated for *no burn-out* performance. Five-year warranty.

“Pinkel” Dual-band Filter Sets – single-band exciters, dual-band emitters and beamsplitters (See page 31 for Technical Note)

These items ship same day!

Set / Primary Fluorophores	Center Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers	
<b>DA/Fl-2X-A Pinkel Set</b>  Blue: DAPI, Hoechst, AMCA, BFP, Alexa Fluor® 350 Green: FITC, GFP, rsGFP, Bodipy, Alexa Fluor® 488  <i>Dual-band</i>	387 nm	> 90 % over 11 nm	Single-band Exciter FF01-387/11-25	
	485 nm	> 93% over 20 nm	Single-band Exciter FF01-485/20-25	
	433 nm 530 nm	> 90% over 38 nm > 90% over 40 nm	Dual-band Emitter FF01-433/530-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 97% 370 – 393 nm > 97% 466 – 495 nm		> 97% 414 – 452 nm > 97% 510 – 550 nm	Dual-band Dichroic FF403/502-Di01-25x36
<b>Unmounted Full Set:</b>			<b>DA/Fl-2X-A-000</b>	
<b>CFP/YFP-2X-A Pinkel Set</b>  Cyan: CFP, AmCyan, SYTOX Blue, BOBO-1, BO-PRO-1 Yellow: YFP, Calcium Green-1, Eosin, Rhodamine 123  <i>Dual-band</i>	427 nm	> 93% over 10 nm	Exciter 1 FF01-427/10-25	
	504 nm	> 93% over 12 nm	Exciter 2 FF01-504/12-25	
	464 nm 547 nm	> 90% over 23 nm > 90% over 31 nm	Dual-band Emitter FF01-464/547-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 415 – 432 nm > 95% 493 – 511 nm		> 90% 449 – 483 nm > 90% 530 – 569 nm	Dual-band Dichroic FF440/520-Di01-25x36
<b>Unmounted Full Set:</b>			<b>CFP/YFP-2X-A-000</b>	
<b>GFP/DsRed-2X-A Pinkel Set</b>  Green: GFP, rsGFP, FITC, Alexa Fluor® 488 Red: DsRed, TRITC, Cy3™, Texas Red®, Alexa Fluor® 568 & 594  <i>Dual-band</i>	470 nm	> 93% over 22 nm	Exciter 1 FF01-470/22-25	
	556 nm	> 93% over 20 nm	Exciter 2 FF01-556/20-25	
	512 nm 630 nm	> 90% over 23 nm > 90% over 91 nm	Dual-band Emitter FF01-512/630-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 456 – 480 nm > 95% 541 – 565 nm		> 90% 500 – 529 nm > 90% 584 – 679 nm	Dual-band Dichroic FF493/574-Di01-25x36
<b>Unmounted Full Set:</b>			<b>GFP/DsRed-2X-A-000</b>	
<b>GFP/HcRed-2X-A Pinkel Set</b>  Green: GFP, rsGFP, FITC, Alexa Fluor® 488 Red: HcRed, Cy3.5™, Texas Red®, Alexa Fluor® 594  <i>Dual-band</i>	474 nm	> 90% over 23 nm	Exciter 1 FF01-474/23-25	
	585 nm	> 90% over 29 nm	Exciter 2 FF01-585/29-25	
	527 nm 645 nm	> 90% over 42 nm > 90% over 49 nm	Dual-band Emitter FF01-527/645-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 454 – 485 nm > 95% 570 – 598 nm		> 90% 505 – 550 nm > 90% 620 – 675 nm	Dual-band Dichroic FF495/605-Di01-25x36
<b>Unmounted Full Set:</b>			<b>GFP/HcRed-2X-A-000</b>	
<b>FITC/TxRed-2X-A Pinkel Set</b>  Green: FITC, GFP, rsGFP, Bodipy, Alexa Fluor® 488 Red: Texas Red®, mCherry, Alexa Fluor® 568 & 594  <i>Dual-band</i>	485 nm	> 93% over 20 nm	Exciter 1 FF01-485/20-25	
	586 nm	> 93% over 20 nm	Exciter 2 FF01-586/20-25x5	
	524 nm 628 nm	> 90% over 29 nm > 90% over 33 nm	Dual-band Emitter FF01-524/628-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 458 – 499 nm > 95% 570 – 600 nm		> 90% 509 – 541 nm > 90% 612 – 647 nm	Dual-band Dichroic FF505/606-Di01-25x36
<b>Unmounted Full Set:</b>			<b>FITC/TxRed-2X-A-000</b>	
<b>Cy3/Cy5-2X-A Pinkel Set</b>  Yellow: Cy3™, DsRed, Alexa Fluor® 555 Red: Cy5™, SpectrumFRed™, Alexa Fluor® 647 & 660  <i>Dual-band</i>	534 nm	> 90% over 30 nm	Exciter 1 FF01-534/30-25	
	628 nm	> 93% over 40 nm	Exciter 2 FF01-628/40-25	
	577 nm 690 nm	> 90% over 24 nm > 90% over 50 nm	Dual-band Emitter FF01-577/690-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 514 – 553 nm > 95% 617 – 652 nm		> 90% 564 – 591 nm > 90% 665 – 718 nm	Dual-band Dichroic FF560/659-Di01-25x36
<b>Unmounted Full Set:</b>			<b>Cy3/Cy5-2X-A-000</b>	

**New!**



Filter Specifications on page 34

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# BrightLine® Multiband Fluorescence Sets

Extensive selection.  
30-day return policy.

## "Pinkel" Triple-band Filter Sets

**These items ship same day!**

Set / Primary Fluorophores	Center Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers	
<b>BFP/GFP/HcRed-3X-A Pinkel Set</b>  Blue: BFP, DAPI, Hoechst, AMCA, Alexa Fluor® 350 Green: GFP, rsGFP, FITC, Alexa Fluor® 488 Red: HcRed, Cy3.5™, Texas Red®, Alexa Fluor® 594  <i>Triple-band</i>	370 nm	> 90% over 36 nm	Exciter 1 FF01-370/36-25	
	474 nm	> 90% over 23 nm	Exciter 2 FF01-474/23-25	
	585 nm	> 90% over 29 nm	Exciter 3 FF01-585/29-25	
	425 nm 527 nm 685 nm	> 90% over 35 nm > 90% over 42 nm > 90% over 130 nm	Triple-band Emitter FF01-425/527/685-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 97% 354 – 385 nm > 97% 465 – 483 nm > 97% 570 – 596 nm		> 95% 403 – 446 nm > 95% 502 – 552 nm > 95% 620 – 750 nm	
<b>Unmounted Full Set:</b>			<b>BFP/GFP/HcRed-3X-A-000</b>	
<b>CFP/YFP/HcRed-3X-A Pinkel Set</b>  Cyan: CFP, AmCyan, SYTOX Blue, BOBO-1, BO-PRO-1 Yellow: YFP, Calcium Green-1, Fluo-3, Rhodamine 123 Red: HcRed, Cy3.5™, Texas Red®, Alexa Fluor® 594  <i>Triple-band</i>	427 nm	> 93% over 10 nm	Exciter 1 FF01-427/10-25	
	504 nm	> 93% over 12 nm	Exciter 2 FF01-504/12-25	
	589 nm	> 93% over 15 nm	Exciter 3 FF01-589/15-25	
	464 nm 542 nm 639 nm	> 90% over 23nm > 90% over 27 nm > 90% over 42 nm	Triple-band Emitter FF01-464/542/639-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 420 – 430 nm > 95% 496 – 510 nm > 95% 579 – 596 nm		> 90% 451 – 480 nm > 90% 530 – 561 nm > 90% 618 – 664 nm	
<b>Unmounted Full Set:</b>			<b>CFP/YFP/HcRed-3X-A-000</b>	
<b>DA/FI/TX-3X-A Pinkel Set</b>  Blue: DAPI, Hoechst, AMCA, BFP, Alexa Fluor® 350 Green: FITC, GFP, rsGFP, BoDipy, Alexa Fluor® 488 Red: Texas Red®, MitoTracker Red, Alexa Fluor® 568 & 594  <i>Triple-band</i>	387 nm	> 90% over 11 nm	Exciter 1 FF01-387/11-25	
	494 nm	> 93% over 20 nm	Exciter 2 FF01-494/20-25	
	575 nm	> 93% over 25 nm	Exciter 3 FF01-575/25-25	
	457 nm 530 nm 628 nm	> 80% over 22 nm > 85% over 20 nm > 85% over 28 nm	Triple-band Emitter FF01-457/530/628-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 97.5% 394 – 414 nm > 97.5% 484 – 504 nm > 97.5% 566 – 586 nm		> 90% 446 – 468 nm > 90% 520 – 540 nm > 90% 614 – 642 nm	
<b>Unmounted Full Set:</b>			<b>DA/FI/TX-3X-A-000</b>	
<b>DA/FI/TR/Cy5-4X-A Pinkel Set</b>  Blue: DAPI, Hoechst, AMCA, Alexa Fluor® 350 Green: FITC, GFP, rsGFP, Bodipy, AlexaFluor® 488 Orange: TRITC, Cy3™, Texas Red®, MitoTracker Red, Alexa Fluor® 568 & 594 Red: Cy5™, APC, TOTO-3, TO-PRO-3, Alexa Fluor® 647 & 660  <i>Quad-band</i>  The flagship of multiband sets!	387 nm	> 90% over 11 nm	Exciter 1 FF01-387/11-25	
	485 nm	> 93% over 20 nm	Exciter 2 FF01-485/20-25	
	560 nm	> 93% over 25 nm	Exciter 3 FF01-560/25-25	
	650 nm	> 93% over 13 nm	Exciter 4 FF01-650/13-25	
	440 nm 521 nm 607 nm 700 nm	> 90% over 40 nm > 90% over 21 nm > 90% over 34 nm > 90% over 45 nm	Quad-band Emitter FF01-440/521/607/700-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 381 – 392 nm > 95% 475 – 495 nm > 95% 547 – 572 nm > 95% 643 – 656 nm		> 90% 420 – 460 nm > 90% 510 – 531 nm > 90% 589 – 623 nm > 90% 677 – 722 nm	
	<b>Unmounted Full Set:</b>			<b>DA/FI/TR/Cy5-4X-A-000</b>



Filter Specifications on page 34

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# BrightLine® Multiband Fluorescence Sets

Every Semrock filter is hard-coated for *no burn-out* performance. Five-year warranty.

“Sedat” Dual-band Filter Sets – single-band exciters and emitters, multiband beamsplitters (See page 31 for definitions)

**These items ship same day!**

Set / Primary Fluorophores	Center Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers	
<b>DA/FI-2X2M-A Sedat Set</b>  Blue: DAPI, Hoechst, AMCA, BFP, Alexa Fluor® 350 Green: FITC, GFP, rsGFP, Bodipy, Alexa Fluor® 488  <i>Dual-band</i>	387 nm	> 90% over 11 nm	Exciter 1 FF01-387/11-25	
	485 nm	> 93% over 20 nm	Exciter 2 FF01-485/20-25	
	435 nm	> 90% over 40 nm	Emitter 1 FF01-435/40-25	
	531 nm	> 93% over 40 nm	Emitter 2 FF01-531/40-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 97% 370 – 393 nm	> 90% 414 – 452 nm	Dichroic	
	> 97% 466 – 495 nm	> 90% 510 – 550 nm	FF403/502-Di01-25x36	
<b>Unmounted Full Set:</b>			<b>DA/FI-2X2M-A-000</b>	
<b>CFP/YFP-2X2M-A Sedat Set</b>  Cyan: CFP, AmCyan, SYTOX Blue, BOBO-1, BO-PRO-1 Yellow: YFP, Calcium Green-1, Eosin, Rhodamine 123  <i>Dual-band</i>	427 nm	> 93% over 10 nm	Exciter 1 FF01-427/10-25	
	504 nm	> 93% over 12 nm	Exciter 2 FF01-504/12-25	
	472 nm	> 93% over 30 nm	Emitter 1 FF01-472/30-25	
	542 nm	> 93% over 27 nm	Emitter 2 FF01-542/27-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 415 – 432 nm	> 90% 449 – 483 nm	Dichroic	
	> 95% 493 – 511 nm	> 90% 530 – 569 nm	FF440/520-Di01-25x36	
<b>Unmounted Full Set:</b>			<b>CFP/YFP-2X2M-A-000</b>	
<b>GFP/DsRed-2X2M-B Sedat Set</b>  Green: GFP, rsGFP, FITC, Alexa Fluor® 488 Red: DsRed, TRITC, Cy3™, Texas Red®, Alexa Fluor® 568 & 594  <i>Dual-band</i>	470 nm	> 93% over 22 nm	Exciter 1 FF01-470/22-25	
	556 nm	> 93% over 20 nm	Exciter 2 FF01-556/20-25	
	514 nm	> 93% over 30 nm	Emitter 1 FF01-514/30-25	
	617 nm	> 90% over 73 nm	Emitter 2 FF01-617/73-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 456 – 480 nm	> 90% 500 – 529 nm	Dichroic	
	> 95% 541 – 565 nm	> 90% 584 – 679 nm	FF493/574-Di01-25x36	
<b>Unmounted Full Set:</b>			<b>GFP/DsRed-2X2M-B-000</b>	
<b>FITC/TxRed-2X2M-A Sedat Set</b>  Green: FITC, GFP, rsGFP, BoDipy, Alexa Fluor® 488 Red: Texas Red®, mCherry, Alexa Fluor® 568 & 594  <i>Dual-band</i>	485 nm	> 93% over 20 nm	Exciter 1 FF01-485/20-25	
	586 nm	> 93% over 20 nm	Exciter 2 FF01-586/20-25x5	
	536 nm	> 93% over 40 nm	Emitter 1 FF01-536/40-25	
	628 nm	> 93% over 32 nm	Emitter 2 FF01-628/32-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 458 – 499 nm	> 90% 509 – 541 nm	Dichroic	
	> 95% 570 – 600 nm	> 90% 612 – 647 nm	FF505/606-Di01-25x36	
<b>Unmounted Full Set:</b>			<b>FITC/TxRed-2X2M-A-000</b>	
<b>Cy3/Cy5-2X2M-A Sedat Set</b>  Yellow: Cy3™, DsRed, Alexa Fluor® 555 Red: Cy5™, SpectrumFRed™, Alexa Fluor® 647 & 660  <i>Dual-band</i>	534 nm	> 90% over 30 nm	Exciter 1 FF01-534/30-25	
	628 nm	> 93% over 40 nm	Exciter 2 FF01-628/40-25	
	585 nm	> 90% over 40 nm	Emitter 1 FF01-585/40-25	
	692 nm	> 93% over 40 nm	Emitter 2 FF01-692/40-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 514 – 553 nm	> 90% 564 – 591 nm	Dichroic	
	> 95% 617 – 652 nm	> 90% 665 – 718 nm	FF560/659-Di01-25x36	
<b>Unmounted Full Set:</b>			<b>Cy3/Cy5-2X2M-A-000</b>	



Cubes  
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(continued)

Filter Specifications on page 34

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# BrightLine® Multiband Fluorescence Sets

Extensive selection.  
30-day return policy.

## “Sedat” Triple- and Quad-band Filter Sets (continued)

These items ship same day!

Set / Primary Fluorophores	Center Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers	
<b>CFP/YFP/HcRed-3X3M-A Sedat Set</b>  Cyan: CFP, AmCyan, SYTOX Blue, BOBO-1, BO-PRO-1 Yellow: YFP, Calcium Green-1, Fluo-3, Rhodamine 123 Red: HcRed, Cy3.5™, Texas Red®, Alexa Fluor® 594  Triple-band	427 nm	> 93% over 10 nm	Exciter 1 FF01-427/10-25	
	504 nm	> 93% over 12 nm	Exciter 2 FF01-504/12-25	
	589 nm	> 93% over 15 nm	Exciter 3 FF01-589/15-25	
	472 nm	> 93% over 30 nm	Emitter 1 FF01-472/30-25	
	542 nm	> 93% over 27 nm	Emitter 2 FF01-542/27-25	
	632 nm	> 93% over 22 nm	Emitter 3 FF01-632/22-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 420 – 430 nm		> 90% 451 – 480 nm	
	> 95% 496 – 510 nm		> 90% 530 – 561 nm	
	> 95% 579 – 596 nm		> 90% 618 – 664 nm	
<b>Unmounted Full Set:</b>			<b>CFP/YFP/HcRed-3X3M-A-000</b>	
<b>DA/FI/TX-3X3M-A Sedat Set</b>  Blue: DAPI, Hoechst, AMCA, BFP, Alexa Fluor® 350 Green: FITC, GFP, rsGFP, Bodipy, Alexa Fluor® 488 Red: Texas Red®, MitoTracker Red, Alexa Fluor® 568 & 594  Triple-band	387 nm	> 90% over 11 nm	Exciter 1 FF01-387/11-25	
	494 nm	> 93% over 20 nm	Exciter 2 FF01-494/20-25	
	575 nm	> 93% over 25 nm	Exciter 3 FF01-575/25-25	
	447 nm	> 93% over 60 nm	Emitter 1 FF02-447/60-25	
	531 nm	> 90% over 22 nm	Emitter 2 FF01-531/22-25	
	624 nm	> 93% over 40 nm	Emitter 3 FF01-624/40-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 394 – 414 nm		> 90% 446 – 468 nm	
	> 95% 484 – 504 nm		> 90% 520 – 540 nm	
	> 95% 566 – 586 nm		> 90% 614 – 642 nm	
<b>Unmounted Full Set:</b>			<b>DA/FI/TX-3X3M-A-000</b>	
<b>DA/FI/TR/Cy5-4X4M-B Sedat Set</b>  Blue: DAPI, Hoechst, AMCA, Alexa Fluor® 350 Green: FITC, GFP, rsGFP, Bodipy, Alexa Fluor® 488 Orange: TRITC, Cy3™, Texas Red®, MitoTracker Red, Alexa Fluor® 568 & 594 Red: Cy5™, APC, TOTO-3, TO-PRO-3, Alexa Fluor® 647 & 660  Quad-band	387 nm	> 90% over 11 nm	Exciter 1 FF01-387/11-25	
	485 nm	> 93% over 20 nm	Exciter 2 FF01-485/20-25	
	560 nm	> 93% over 25 nm	Exciter 3 FF01-560/25-25	
	650 nm	> 93% over 13 nm	Exciter 4 FF01-650/13-25	
	440 nm	> 93% over 40 nm	Emitter 1 FF01-440/40-25	
	525 nm	> 90% over 30 nm	Emitter 2 FF01-525/30-25	
	607 nm	> 93% over 36 nm	Emitter 3 FF01-607/36-25	
	684 nm	> 90% over 24 nm	Emitter 4 FF01-684/24-25	
	<b>Avg. Reflection / Bandwidth</b>		<b>Avg. Transmission / Bandwidth</b>	
	> 95% 381 – 392 nm		> 90% 420 – 460 nm	
> 95% 475 – 495 nm		> 90% 510 – 531 nm		
> 95% 547 – 572 nm		> 90% 589 – 623 nm		
> 95% 643 – 656 nm		> 90% 677 – 722 nm		
<b>Unmounted Full Set:</b>			<b>DA/FI/TR/Cy5-4X4M-B-000</b>	



Cubes  
Page 32

Filter Specifications on page 34

If you use a Leica microscope, all BrightLine single-band bandpass filters in “Pinkel” and “Sedat” sets, including for Leica microscopes, come with standard 25 mm (32 mm optional) exciters and 25 mm emitters, which are packaged separately for convenient mounting in standard filter wheels. For set part numbers for Leica microscopes, see [www.semrock.com](http://www.semrock.com).

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# BrightLine® Laser Fluorescence Multiband Sets

**New!**

Every Semrock filter is hard-coated for *no burn-out* performance. Five-year warranty.



Unlock the full potential of your laser fluorescence imaging system.

Crafted to take advantage of the superior resolution, higher sensitivity, and better image fidelity offered by today's state-of-the-art laser-based microscopes – including laser-scanning and spinning-disk confocal and TIRF microscopes. They are optimized for the most popular lasers used in fluorescence imaging, including newer all-solid-state lasers that are rapidly replacing older gas-laser technology.

## “Full Multiband” Filter Sets – multiband exciters, emitters and beamsplitters

**These items ship same day!**

Set / Laser Lines / Primary Fluorophores	Center Wavelength	Avg. Transmission / Bandwidth	Filter / Set Part Numbers
<b>LF488/561-A</b>  Green: GFP (EGFP), FITC (Fluorescein) Red: mCherry (RFP)  <i>Dual-band</i>	482 nm 563 nm	> 93% over 18 nm > 93% over 9 nm	Dual-band Exciter FF01-482/563-25
	523 nm 610 nm	> 93% over 40 nm > 93% over 52 nm	Dual-band Emitter FF01-523/610-25
	<b>Avg. Reflection / Bandwidths</b>		<b>Avg. Transmission / Bandwidth</b>
	> 94% 471 – 491 nm > 94% 559 – 568 nm	>93% 503 – 543 nm >93% 582 – 800 nm	Dual-band Dichroic Di01-R488/561-25x36
<b>Unmounted Full Set:</b>			<b>LF488/561-A-000</b>

**New!**

<b>LF405/488/561/635-A</b>  Blue: DAPI Green: FITC (Fluorescein), GFP (EGFP) Orange: mCherry (RFP) Red: Cy5™  <i>Quadband</i>	390 nm 482 nm 563 nm 640 nm	> 85% over 40 nm > 90% over 18 nm > 90% over 9 nm > 90% over 14 nm	Quad-band Exciter FF01-390/482/563/640-25
	446 nm 523 nm 600 nm 677 nm	> 90% over 32 nm > 90% over 42 nm > 90% over 35 nm > 90% over 27 nm	Quad-band Emitter FF01-446/523/600/677-25
	<b>Avg. Reflection / Bandwidths</b>		<b>Avg. Transmission / Bandwidth</b>
	> 94% 370 – 410 nm > 94% 473 – 491 nm > 94% 559 – 568 nm > 94% 633 – 647 nm	93% 429.5 – 462.0 nm 93% 502.5 – 544 nm 93% 582 – 619 nm 93% 661 – 800 nm	Quad-band Dichroic Di01-R405/488/561/635-25x36
<b>Unmounted Full Set:</b>			<b>LF405/488/561/635-A-000</b>

**New!**

## “Pinkel” Multiband Filter Set – single-band exciters, multiband emitter and beamsplitter

<b>LF488/561-2X-A</b>  Green: GFP (EGFP), FITC (Fluorescein) Red: mCherry (RFP)	482 nm	> 93% over 18 nm	Exciter 1 FF01-482/18-25
	563 nm	> 93% over 9 nm	Exciter 2 FF01-563/9-25
	523 nm 610 nm	> 93% over 40 nm > 93% over 52 nm	Dual-band Emitter FF01-523/610-25
	<b>Avg. Reflection / Bandwidths</b>		<b>Avg. Transmission / Bandwidth</b>
> 94% 471 – 491 nm > 94% 559 – 568 nm	> 93% 503 – 543 nm > 93% 582 – 800 nm	Dual-band Dichroic Di01-R488/561-25x36	
<b>Unmounted Full Set:</b>			<b>LF488/561-2X-A-000</b>

**New!**

## “Sedat” Multiband Filter Set – single-band exciters and emitters, multiband beamsplitter

<b>LF488/561-2X2M-A</b>  Green: GFP (EGFP), FITC (Fluorescein) Red: mCherry (RFP)	482 nm	> 93% over 18 nm	Exciter 1 FF01-482/18-25
	563 nm	> 93% over 9 nm	Exciter 2 FF01-563/9-25
	525 nm	> 93% over 45 nm	Emitter 1 FF01-525/45-25
	609 nm	> 93% over 54 nm	Emitter 2 FF01-609/54-25
<b>Avg. Reflection / Bandwidths</b>		<b>Avg. Transmission / Bandwidth</b>	
> 94% 471 – 491 nm > 94% 559 – 568 nm	> 93% 503 – 543 nm > 93% 582 – 800 nm	Dual-band Dichroic Di01-R488/561-25x36	
<b>Unmounted Full Set:</b>			<b>LF488/561-2X2M-A-000</b>

**New!**



Cubes  
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Filter Specifications on page 34

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)



## TECHNICAL NOTE

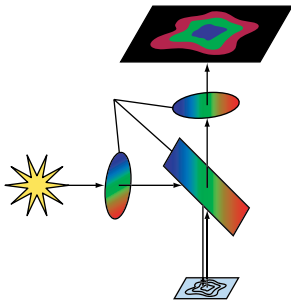
### Multiband Filter Set Configurations

The ability to label multiple, distinct objects of interest in a single sample greatly enhances the power of fluorescence imaging. One way to achieve high-quality images of such samples has been to take multiple photographs while switching single-band filter cubes between photographs, and then later to combine these photographs electronically. Limitations to this approach historically included "pixel shift" among the multiple monochrome images, and the speed with which a complete multicolor image could be captured. Semrock solved the problem of "pixel shift" with its BrightLine ZERO™ technology (see page 11 for a complete explanation), and the single-band filter cube approach remains the best technique for achieving images with the highest contrast and lowest bleedthrough possible. But with the increasing demand for high-speed imaging, especially for live-cell real-time analysis using fluorescent protein labels, there is a need for an alternative to the single-band filter cube approach that does not sacrifice too much image fidelity. Now Semrock's advanced multiband optical filter technology brings simultaneous multicolor imaging to a new level!

There are three types of multiband filter sets for simultaneous multicolor imaging. The "full multiband" configuration uses all multiband filters – exciter, emitter, and dichroic beamsplitter – and is ideal for direct visualization, such as locating areas of interest on a sample. This approach is quick and easy to implement, and is compatible with all standard fluorescence microscopes. However, it requires a color camera for electronic imaging and cannot eliminate fluorophore bleedthrough. The "Pinkel" configuration uses single-band exciter in a filter wheel with multiband emitter and dichroic filters. It offers an economical way to achieve very high-speed, high-contrast, simultaneous multi-color imaging. This approach is based on a monochrome CCD camera, which is less expensive and offers better noise performance than color cameras. While bleedthrough is reduced relative to the full-multiband approach, some bleedthrough is still possible since all emission bands are imaged simultaneously. The "Sedat" configuration uses single-band exciters and single-band emitters in synchronized filter wheels, with a multiband dichroic beamsplitter. This approach provides the best image fidelity for high-speed simultaneous multi-color imaging, though it requires a larger investment in system hardware. See [www.semrock.com](http://www.semrock.com) for our 2006 BioPhotonics International article.

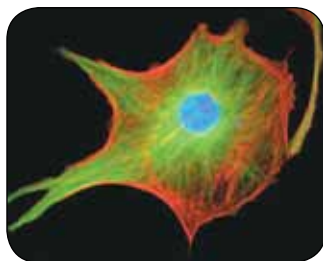
#### "Full Multiband" Configuration

(Multiband exciter, multiband emitter, & multiband dichroic)



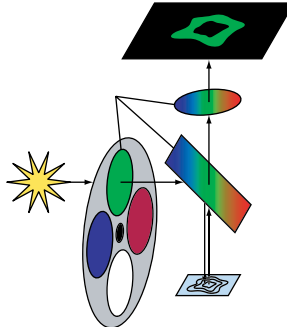
#### "Full Multiband" Image

Multi-color image captured with a color CCD camera



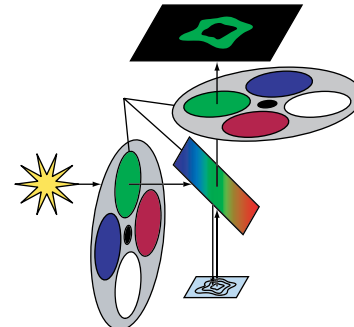
#### "Pinkel" Configuration

(Multiband emitter, multiband dichroic, & single-band exciters)



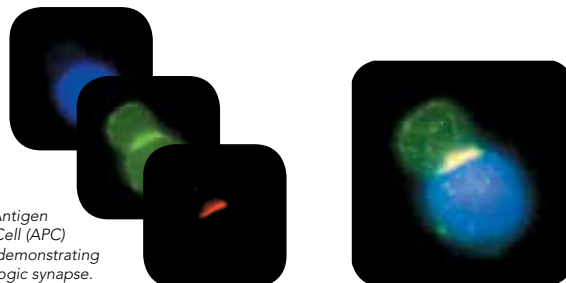
#### "Sedat" Configuration

(Multiband dichroic, single-band exciters, & single-band emitters)



#### "Pinkel" and "Sedat" Composite Image

Single-color images are combined electronically to produce one high-fidelity, multi-color image.



T-Cell and Antigen Presenting Cell (APC) conjugates demonstrating an immunologic synapse. Samples courtesy of Beth Graf and Dr. Jim Miller at the University of Rochester Medical Center.

# Fluorescence Filter Cubes



Microscope Brand / Compatible Microscopes	Semrock Cube Designation	Cube Price*	Cube Part Number	Filter Set Part Number Mounted in Cube
<b>Nikon</b>				
TE2000, 80i, 90i, 50i, and any using the Epi-fluor Illuminator	TE2000	\$350	NTE	<Set Part Number>-NTE
E200, E400, E600, E800, E1000, TS100, TS100F, TE200, TE300, ME600L, L150A, and some Labophot, Optiphot, and Diaphot series	Quadfluor	\$350	NQF	<Set Part Number>-NQF
<b>Olympus</b>				
AX, BX, and IX series	U-MF2	\$385	OMF	<Set Part Number>-OMF
MVX10 (and other large optical path microscopes)	U-MF/XL	\$385	OXL	<Set Part Number>-OXL
<b>Zeiss</b>				
Axio Imager, Axio Observer, Axioplan2i, Axioplan2ie, Axiovert200, and Axioskop2 (post-2001)	FL CUBE EC P&C	\$295	ZHE	<Set Part Number>-ZHE
Axioplan (pre-version 2), Axiovert100, and Axioskop2 (pre-2002)	Threaded Filter Cube	\$295	ZAT	<Set Part Number>-ZAT
<b>Leica</b>				
DM-2000, DM-2500, DM-3000, DMI 3000 B, DM-4000, DM-4000 B, DM-5000, DM-5500, DM-6000 and DM-6000 B	DM-K	\$395	LDMK	<Set Part Number>-LDMK
Aristomet, Aristoplan, DM-LB, DM-LM, DM-LP, DM-RB, and DM-R HCRF4	DM-R	\$395	LLC	<Set Part Number>-LLC
DM-750, DM-1000, DM-IL, DM-IL-LED, DM-IRB, DM-IRE2, DM-LS, DM-LSP, DM-R HCRF8, DM-R XARF8, and Older Models (like Diavert) with Ploem-OPAK	DM-IRB	\$395	LSC	<Set Part Number>-LSC

\* Purchased separately or with set

For a cube mounted set, replace "-000" with the cube part number from above (e.g. use FITC-3540B-NTE).

Nikon, NTE

Nikon, NQF

Olympus, OMF

Olympus, OXL

Zeiss, ZHE

Zeiss, ZAT

Leica, LDMK

Leica, LLC



**New!**

See online video tutorials on how to mount filters in your cube at [www.semrock.com](http://www.semrock.com)!

### Nikon, Olympus & Zeiss Microscopes

- Prices on pages 9-30 are for filters that fit most standard cubes for these microscopes. See page 34 for dimensions.
- For filters and set pricing based on Olympus U-MF/XL ("-OXL") cubes, see [www.semrock.com](http://www.semrock.com).
- Multi-exciter sets are also available with 32 mm diameter exciters.

### Leica Microscopes

- Leica single-band, FURA-2, and FRET sets are available only as BrightLine ZERO™ sets (except for BrightLine Basic™, TRP-A, QDLP-A, and Laser Fluorescence sets).
- Listings in this catalog apply to current Leica "large format" filter sets. When building your complete part number, add "-L01-ZERO" after the set part number to indicate an unmounted "large format" set (or add "-LDMK-ZERO" or "-LLC-ZERO" for sets mounted in cubes).
- For legacy "small-format" filter sets, when building your complete part number, add "-L02-ZERO" after the set part number to indicate an unmounted "small format" set (or add "-LSC-ZERO" for a set mounted in a cube).

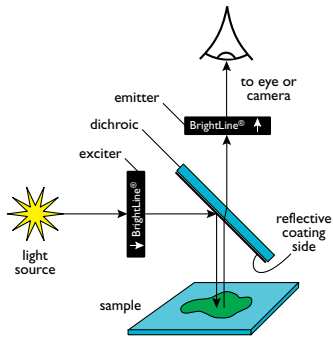
### For Certified BrightLine ZERO Upgrades

- Obtain "zero pixel shift" performance by adding the zero option indicated in the part number. (see page 11).

## PRODUCT NOTE

### Orientation of Filters in a Microscope

Because BrightLine filters are so durable, you can readily populate your own cubes, sliders, and filter wheels. To obtain the optimal performance from the filters, they should be oriented properly.



The exciter and emitter should be oriented so that the arrow on the side of the aluminum ring points in the direction of propagation of the desired light – from the light source to dichroic for the exciter and from the dichroic to eye or camera for the emitter. The dichroic must be oriented such that the reflective coating side faces toward the exciter or light source and the sample.

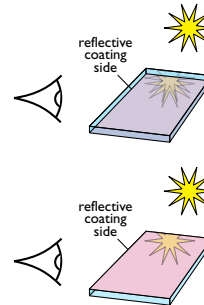


### Marked Dichroics

If the dichroic has an engraved Semrock logo, a small linear mark, or a corner chamfered, the reflective coating side is facing you when the dichroic long axis is vertical and the logo, mark, or chamfer is in the upper left (or lower right) corner.

### Unmarked Dichroics

When viewing the dichroic with the reflective coating side down, you can see a double-reflection of a bright object and the thickness of the filter at the far edge is apparent.



When viewing the dichroic with the reflective coating side up, you can see a predominantly single reflection of a bright object and the thickness of the filter at the far edge is not visible.

## TECHNICAL NOTE

### You Can Clean Semrock Optical Filters!

Semrock manufactures the most durable optical filters available. However, it is important to note that while all optical components should be handled with care, soft-coated filters are especially susceptible to damage by handling and cleaning. Fortunately Semrock supplies only hard-coated filters, so all of Semrock's filters may be readily cleaned using the following recommended method.

The following are recommended to properly clean your filters:

- **Unpowdered laboratory gloves** prevent finger oils from contaminating the glass and keep solvents from contacting skin;
- **Eye protection** is critical to avoid getting any solvent in your eyes;
- **Compressed air** – clean, filtered laboratory compressed nitrogen or air is ideal, but “canned” compressed air or even a rubber “bulb blower” in a relatively clean environment is acceptable;
- **Lint-free swab** – cotton-based swabs work best;
- **Lens cleaning tissue** – lint-free tissue paper is also acceptable;
- **Cleaning solvent** – we recommend Isopropyl Alcohol (IPA) and/or Acetone. Care should be taken when handling these solvents, especially to avoid ingestion.

1. **Blow off contaminants.** Many contaminants are loosely attached to the surface and can be blown off. Using laboratory gloves, hold the filter in one hand and aim the air stream away from the filter. Start the air stream using a moderate air flow. Maintaining an oblique angle to the part – never blow straight on the filter surface – now bring the air stream to the filter, and slowly move it across the surface. Repeat until no more loose particles are disappearing.
2. **Clean filter.** If dust or debris remains, it is probably “stuck” to the surface and must be removed with mechanical force and/or chemical action. Create a firm but “pointy” tip with the lint-free wipe or lens tissue by folding it multiple times into a triangular shape or wrapping it around a swab. Lint-free swabs may also be used directly in place of a folded wipe. Moisten the wipe or swab with either IPA or Acetone, but avoid too much excess solvent.

**New!**

See video tutorial on how to clean your optical filters at [www.semrock.com](http://www.semrock.com)

The key to cleaning the optic is to maintain one continuous motion at as constant a speed as possible. Some people prefer to clean using a “figure 8” pattern while others choose to start in the center of the part and wipe outward in a spiral pattern. Do not stop the wipe on the surface – keep the wipe moving at a constant speed, lifting the moving wipe off the part when you reach the end of the pattern.



3. **Inspect filter.** Use a room light or any bright light source to inspect the optic to ensure that it is clean. Tip, tilt, and rotate the optic while viewing it as close to your eye as you can focus. If contamination remains, start with a brand new wipe or swab and repeat step 2 above.
4. **Repeat** steps 1 – 3 for the other side of the filter if contamination exists.

**Note:** IPA and Acetone each have pros and cons, so choose the solvent that works best for you after trying both. Generally the more active the solvent the better, to attack a broader range of contaminants more quickly. However, it is critical to ensure that the solvent is wiped into a very thin film before it evaporates. IPA strikes a good balance between cleaning action and level of skill required. It is not very aggressive, and thus may require more cleaning attempts or greater mechanical pressure, but it dries relatively slowly, thus allowing more time to ensure that every part of the surface is wiped. Acetone has excellent cleaning action and attacks a wide range of contaminants quickly, but it dries very quickly and is thus much more susceptible to leaving behind residue on the surface of the optic where it was not wiped. Furthermore, care should be taken when using Acetone around certain plastics and most adhesives, as these can also be dissolved rather quickly.

# BrightLine® Filter Common Specifications (for filters in sets pages 9–30)

## Exciter and Emitter Specifications (except where otherwise noted)

Property	Specification	Comment
Guaranteed Transmission	> 93%	Except BrightLine Basic™ and Qdot®: > 90%; Except Multiband (see set tables) Averaged over the passband
Typical Transmission	> 97%	Except BrightLine Basic and Qdot: > 94% Averaged over the passband
Angle of Incidence	0° ± 5°	Range of angles over which optical specs are guaranteed for collimated light
Cone Half-angle	7°	Filter performance is likely to remain satisfactory up to 10° Centered around the nominal Angle of Incidence
Autofluorescence	Low	
Transverse Dimensions	25.0 mm	Except Leica sizes, see www.semrock.com
Transverse Tolerance	+ 0.0 / - 0.1 mm	
Exciter Thickness	5.0 mm	Black-anodized aluminium ring
Emitter Thickness	3.5 mm	Black-anodized aluminium ring
Thickness Tolerance	± 0.1 mm	Black-anodized aluminium ring
Exciter Clear Aperture	> 21 mm	Except Leica filters: > 85%
Emitter Clear Aperture	> 22 mm	Except BrightLine Basic & Qdot: > 21 mm; Except Leica filters: > 85%
Scratch-Dig	60-40	Except BrightLine Basic: 80-50 Measured within clear aperture
Ring Housing Material	Aluminum, black anodized	
Blocking	BrightLine filters have blocking far exceeding OD 6 as needed to ensure the blackest background, even when using modern low-noise CCD cameras. The blocking is optimized for microscopy applications using our exclusive SpecMaker™ fluorescence filter design software.	

## Dichroic Beamsplitter Specifications (except where otherwise noted)

Property	Specification	Comment
Guaranteed Transmission	> 90%	Averaged over the specified band
Typical Transmission	> 93%	Averaged over the specified band
Reflection	> 98%	Except BrightLine Basic: > 90%; and Multiband (see set tables) Averaged over the specified band
Angle of Incidence	45° ± 1.5°	Range of angles over which optical specs are guaranteed for collimated light
Cone Half-angle	2°	Filter performance is likely to remain satisfactory up to 3° Centered around the nominal Angle of Incidence
Autofluorescence	Ultra-low	
Transverse Dimensions	25.2 x 35.6 mm	Except Leica sizes, see www.semrock.com
Transverse Tolerance	± 0.1 mm	
Thickness	1.05 mm	Except where otherwise noted
Thickness Tolerance	± 0.05 mm	
Clear Aperture	> 80%	Elliptical
Surface Quality	60-40	Except BrightLine Basic: 80-50 Measured within clear aperture
Edge Chipping	Per ANSI/OEOSC OP1.002-2006, American Standard	
Orientation	Reflective coating side should face toward light source and sample (see page 33)	

## General Filter Specifications (all BrightLine filters)

Property	Specification
Coating Type	“Hard” ion-beam-sputtered
Reliability and Durability	Hard-coated technology with epoxy-free, single-substrate construction for unrivaled filter life and no “burn-out” even when subjected to high optical intensities for a prolonged period of time. BrightLine filters are rigorously tested and proven to MIL-STD-810F and MIL-C-48497A environmental standards.
Microscope Compatibility	All BrightLine filters are available to fit Leica, Nikon, Olympus, and Zeiss microscopes.

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# BrightLine® Multiphoton Fluorescence Filters

Extensive selection.  
30-day return policy.

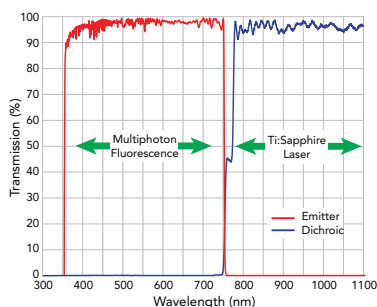


These BrightLine multiphoton ultrahigh-performance fluorescence filters serve a full range of applications, accommodating the wide range of fluorescent dyes that are the essential tools of the modern researcher. The transmission bands of the emitters are so wide that they appear clear at normal incidence. The long-wave-pass dichroic reflection bands are so wide that they look like mirrors when viewed at 45°. These filters virtually eliminate excitation laser noise at the detector. To reduce undesired fluorescence noise outside a desired band, simply add a BrightLine bandpass filter (see pages 37- 41).

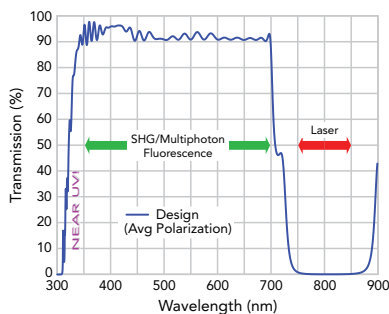
**These items ship same day!**

Product Description	Avg. Transmission / Reflection Bandwidth and Range	Filter Part Numbers
<b>Emission Filters</b>		
Short Wave Pass Emitter <i>Laser Blocking Emission Filter</i>	T <sub>avg</sub> > 90% . . . . . 350 – 650 nm Laser Blocking Range . . . . . OD > 8: 680 – 1040 nm OD > 6: 1040 – 1080 nm	FF01-680/SP-25
Short Wave Pass Emitter <i>Laser Blocking Emission Filter</i>	T <sub>avg</sub> > 90% . . . . . 350 – 650 nm Laser Blocking Range . . . . . OD > 6: 720 – 1100 nm	FF01-720/SP-25 <b>New!</b>
Short Wave Pass Emitter <i>Laser Blocking Emission Filter</i>	T <sub>avg</sub> > 90% . . . . . 380 – 720 nm Laser Blocking Range . . . . . OD > 6: 750 – 1100 nm	FF01-750/SP-25
<b>Long Wave Pass Dichroic Beamsplitters</b>		
Long Wave Pass Dichroic Beamsplitter	T <sub>avg</sub> > 93% . . . . . 680 – 1600 nm R <sub>avg</sub> > 98% . . . . . 350 – 650 nm	FF665-Di02-25x36
Long Wave Pass Dichroic Beamsplitter	T <sub>avg</sub> > 93% . . . . . 720 – 1600 nm R <sub>avg</sub> > 98% . . . . . 350 – 690 nm	FF705-Di01-25x36 <b>New!</b>
Long Wave Pass Dichroic Beamsplitter	T <sub>avg</sub> > 93% . . . . . 750 – 1100 nm R <sub>avg</sub> > 98% . . . . . 350 – 720 nm	FF735-Di01-25x36
<b>Short Wave Pass Dichroic Beamsplitters</b>		
Short Wave Pass Dichroic Beamsplitter	T <sub>avg</sub> > 90% . . . . . 360 – 650 nm R <sub>avg</sub> > 98% (s-polarization) . . . . . 680 – 1080 nm R <sub>avg</sub> > 90% (p-polarization) . . . . . 700 – 1010 nm	FF670-SDi01-25x36
Short Wave Pass Dichroic Beamsplitter <i>Ideal for Second Harmonic Generation (SHG)</i>	T <sub>avg</sub> > 85% (avg. polarization) 370 – 690 nm T > 90% (s- & p-polarizations) 400 – 410 nm R <sub>avg</sub> > 95% (avg. polarization) 750 – 875 nm R > 99% (s- & p-polarizations) 800 – 820 nm	FF720-SDi01-25x36

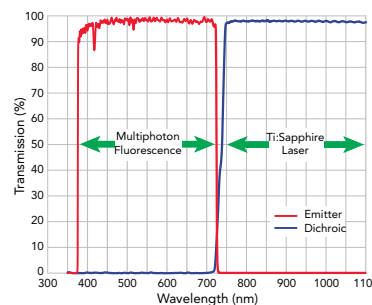
See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)



**FF01-720/SP and FF705-Di01 Spectra**  
Tune your Ti:Sapphire laser down to 720 nm and transmit signals up to 690 nm. Dichroic has extended passband out to 1600 nm for nonlinear laser fluorescence applications.



**FF720-SDi01-25x36 Spectrum**  
Short-wave-pass Dichroic Beamsplitter for SHG  
Low dispersion for minimal pulse broadening.  
Preserves polarization of both excitation and signal beams.



**FF01-750/SP-25 and FF735-Di01-25x36 Spectra**  
Transmits Full Visible – Deep IR Blocking  
These filters provide excellent detection of fluorescence throughout the full visible wavelength range, including red fluorophores like Cy5™.

# Multiphoton Filters Common Specifications

## Common Specifications

Property		Emitter	LWP Dichroic	Comment
Passband Transmission	Guaranteed	> 90%	> 93%	Averaged over any 50 nm (emitter) or 10 nm (dichroic) window within the passband. For SWP dichroic specifications, <i>see page 35</i> .
	Typical	> 95%	> 95%	
Dichroic Reflection	LWP	N/A	> 98%	Averaged over any 30 nm window within the reflection band. For SWP dichroic specifications, <i>see page 35</i> .
Autofluorescence		Ultra-low	Ultra-low	Fused silica substrate
Blocking		Emitter filters have exceptional blocking over the Ti:Sapphire laser range as needed to achieve superb signal-to-noise ratios even when using an extended-response PMT or a CCD camera or other silicon-based detector; see <a href="http://www.semrock.com">www.semrock.com</a> for detailed specifications.		
Pulse Dispersion		LWP dichroic beamsplitters are suitable for use with 100 femtosecond gaussian laser pulses. For SWP dichroic beamsplitters, see Group Delay Dispersion and Polarization Technical Note at <a href="http://www.semrock.com">www.semrock.com</a>		
Emitter Orientation		The emitter orientation does not affect its performance; therefore there is no arrow on the ring to denote a preferred orientation.		
Dichroic Orientation		For the LWP dichroic, the reflective coating side should face toward detector and sample. For the SWP dichroic, the reflective coating side should face towards laser as shown in the diagram on page 33.		
Microscope Compatibility		These filters fit most standard-sized microscope cubes from Nikon, Olympus, and Zeiss and may also be mounted in optical-bench mounts. Contact Semrock for special filter sizes.		

## TECHNICAL NOTE

### Multiphoton Filters

In multiphoton fluorescence microscopy fluorescent molecules that tag targets of interest are excited and subsequently emit fluorescent photons that are collected to form an image. However, in a two-photon microscope, for example, the molecule is not excited with a single photon, as it is in traditional fluorescence microscopy, but instead two photons – each with twice the wavelength – are absorbed simultaneously to excite the molecule.

As shown in Figure 1, a typical system is comprised of an excitation laser, scanning and imaging optics, a sensitive detector (usually a photomultiplier tube), and optical filters for separating the fluorescence from the laser (dichroic beamsplitter) and blocking the laser light from the detector (emission filter).

The advantages offered by multiphoton imaging systems include: true three-dimensional imaging like confocal microscopy; the ability to image deep inside of live tissue; elimination of out-of-plane fluorescence; and reduction of photobleaching away from the focal plane to increase sample longevity. Now Semrock has brought enhanced performance to multiphoton users by introducing optical filters with ultra-high transmission in the passbands, steep transitions, and guaranteed deep blocking everywhere it is needed. Given how much investment is typically required for the excitation laser and other complex elements of multiphoton imaging systems, these filters represent a simple and inexpensive upgrade to substantially boost system performance.

*Exciting research using Semrock multiphoton filters demonstrates the power of fluorescent Ca<sup>2+</sup> indicator proteins (FCIPs) for studying Ca<sup>2+</sup> dynamics in live cells using two-photon microscopy. Three-dimensional reconstructions of a layer 2/3 neuron expressing a fluorescent protein CerTN-L15. Middle: 3 selected images (each taken at depth marked by respective number on the left and right). Image courtesy of Prof. Dr. Olga Garaschuk of the Institute of Neuroscience at the Technical University of Munich. (Modified from Heim et al., Nat. Methods, 4(2): 127-9, Feb. 2007.)*

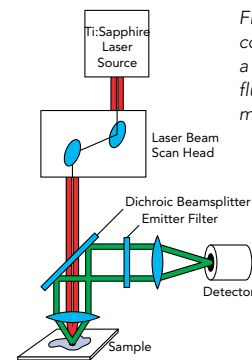
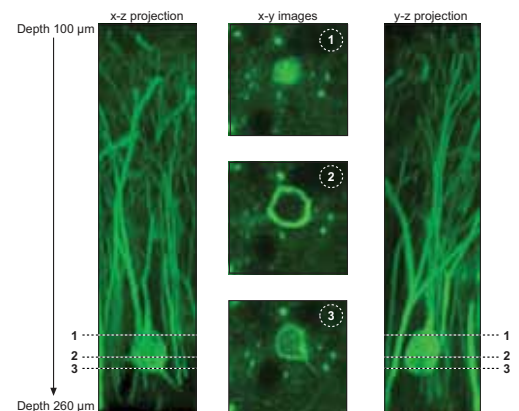


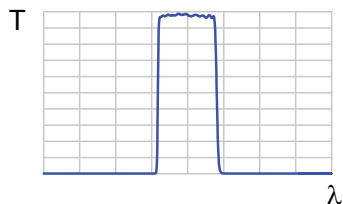
Figure 1: Typical configuration of a multiphoton fluorescence microscope



# BrightLine® Single-band Bandpass Filters

Extensive selection.

Custom-sized filters are available in one week.



Semrock stocks an exceptional range of high-performance, high-reliability individual fluorescence bandpass filters that have been optimized for use in a variety of fluorescence instruments. These filters exclusively utilize our patented single-substrate construction for the highest performance and reliability.

Unless otherwise noted, all filters are housed in a standard 25 mm round black-anodized aluminum ring with thickness as indicated, and a clear aperture of at least 21 mm. Parts denoted with a "-D" are unmounted.

Passband Color	Filter	Center Wavelength	Avg. Transmission / Bandwidth <sup>[1]</sup>	Size (Diameter x Thickness)
●	Hg01-254-25	254 nm	<i>See Mercury Line filters, page 66</i>	
●	FF01-280/20-25	280 nm	> 65% over 20 nm	25 mm x 5 mm
●	FF01-292/15-25	292 nm	> 40% over 15 nm	25 mm x 3.5 mm
●	FF01-295/15-25	295 nm	> 60% over 15 nm	25 mm x 3.5 mm
●	FF01-320/40-25	320 nm	> 70% over 40 nm	25 mm x 5 mm
●	FF01-335/7-25	335 nm	> 75% over 7 nm	25 mm x 5 mm
●	FF01-340/12-25	340 nm	> 75% over 12 nm	25 mm x 3.5 mm
●	FF01-340/26-25	340 nm	> 75% over 26 nm	25 mm x 5 mm
●	FF01-355/40-25	355 nm	> 80% over 40 nm	25 mm x 3.5 mm
●	FF01-357/44-25	357 nm	> 75% over 44 nm	25 mm x 3.5 mm
●	FF01-360/12-25	360 nm	> 75% over 12 nm	25 mm x 5 mm
●	Hg01-365-25	365 nm	<i>See Mercury Line filters, page 66</i>	
●	FF01-370/36-25	370 nm	> 90% over 36 nm	25 mm x 5 mm
●	FF01-375/6-25	375 nm	> 90% over 6 nm	25 mm x 3.5 mm
●	FF01-377/50-25	377 nm	> 85% over 50 nm	25 mm x 5 mm
●	FF01-379/34-25	379 nm	> 90% over 34 nm	25 mm x 5 mm
●	FF01-380/14-25	380 nm	> 80% over 14 nm	25 mm x 5 mm
●	FF01-386/23-25	386 nm	> 90% over 23 nm	25 mm x 5 mm
●	FF01-387/11-25	387 nm	> 90% over 11 nm	25 mm x 5 mm
●	FF01-390/18-25	390 nm	> 90% over 18 nm	25 mm x 5 mm
●	FF01-390/40-25	390 nm	> 93% over 40 nm	25 mm x 5 mm
●	FF01-395/11-25	395 nm	> 85% over 11 nm	25 mm x 3.5 mm
●	LD01-405/10-25	405 nm	<i>See Laser Diode Clean-Up filters, page 65</i>	
●	FF01-405/10-25	405 nm	> 87% over 10 nm	25 mm x 5 mm
●	FF01-406/15-25	406 nm	> 85% over 15 nm	25 mm x 3.5 mm
●	FF01-417/60-25	417 nm	> 90% over 60 nm	25 mm x 5 mm
●	FF01-427/10-25	427 nm	> 93% over 10 nm	25 mm x 5 mm
●	FF01-434/17-25	434 nm	> 90% over 17 nm	25 mm x 5 mm
●	FF01-435/40-25	435 nm	> 90% over 40 nm	25 mm x 5 mm
●	FF01-438/24-25	438 nm	> 93% over 24 nm	25 mm x 5 mm
●	FF01-439/154-25	439 nm	> 93% over 154 nm	25 mm x 5 mm
●	LD01-439/8-25	439 nm	<i>See Laser Diode Clean-Up filters, page 65</i>	
●	FF01-440/40-25	440 nm	> 93% over 40 nm	25 mm x 3.5 mm
●	FF01-442/46-25	442 nm	> 90% over 46 nm	25 mm x 3.5 mm
●	FF01-445/20-25	445 nm	> 90% over 20 nm	25 mm x 5 mm
●	FF01-445/45-25	445 nm	> 90% over 45 nm	25 mm x 5 mm
●	FF02-447/60-25	447 nm	> 93% over 60 nm	25 mm x 3.5 mm
●	FF01-452/45-25	452 nm	> 93% over 45 nm	25 mm x 3.5 mm
●	FF01-457/50-25	457 nm	> 90% over 50 nm	25 mm x 5 mm

<sup>[1]</sup> Bandwidth is the minimum width over which the average transmission exceeds the specified passband transmission; the nominal full-width-at-half-maximum (FWHM) is approximately the Bandwidth + 1% of the Center Wavelength.

(continued)

For graphs, ASCII data and blocking information, go to [www.semrock.com](http://www.semrock.com)

## BrightLine® Single-band Bandpass Filters (continued)

Every Semrock filter is hard-coated for no burn-out performance.

Five-year warranty.

Passband Color	Filter	Center Wavelength	Avg. Transmission / Bandwidth <sup>[1]</sup>	Size (Diameter x Thickness)
●	FF01-460/60-25	460 nm	> 90% over 60 nm	25 mm x 3.5 mm
●	FF02-460/80-25	460 nm	> 90% over 80 nm	25 mm x 5 mm
●	FF01-465/30-25	465 nm	> 90% over 30 nm	25 mm x 5 mm
●	FF01-469/35-25	469 nm	> 90% over 35 nm	25 mm x 5 mm
●	FF01-470/22-25	470 nm	> 93% over 22 nm	25 mm x 5 mm
●	FF01-470/28-25	470 nm	> 90% over 28 nm	25 mm x 5 mm <b>New!</b>
●	FF01-472/30-25	472 nm	> 93% over 30 nm	25 mm x 5 mm
●	FF01-473/10-25	473 nm	> 90% over 10 nm	25 mm x 3.5 mm
●	FF01-474/23-25	474 nm	> 90% over 23 nm	25 mm x 5 mm
●	FF01-475/20-25	475 nm	> 90% over 20 nm	25 mm x 3.5 mm
●	FF01-475/28-25	475 nm	> 90% over 28 nm	25 mm x 5 mm
●	FF01-475/35-25	475 nm	> 90% over 35 nm	25 mm x 5 mm
●	FF01-475/42-25	475 nm	> 90% over 42 nm	25 mm x 5 mm
●	FF01-475/50-25	475 nm	> 90% over 50 nm	25 mm x 5 mm
●	FF01-475/64-25	475 nm	> 90% over 64 nm	25 mm x 3.5 mm
●	FF01-479/40-25	479 nm	> 90% over 40 nm	25 mm x 3.5 mm
●	FF01-480/17-25	480 nm	> 92% over 17 nm	25 mm x 3.5 mm
●	FF01-482/18-25	482 nm	> 93% over 18 nm	25 mm x 5 mm
●	FF01-482/35-25	482 nm	> 93% over 35 nm	25 mm x 5 mm
●	FF01-483/32-25	483 nm	> 93% over 32 nm	25 mm x 3.5 mm
●	FF01-485/20-25	485 nm	> 93% over 20 nm	25 mm x 5 mm
●	FF01-485/70-25	485 nm	> 90% over 70 nm	25 mm x 5 mm
●	FF01-488/6-25	488 nm	> 90% over 6 nm	25 mm x 3.5 mm
●	FF01-494/20-25	494 nm	> 93% over 20 nm	25 mm x 5 mm
●	FF01-494/41-25	494 nm	> 90% over 41 nm	25 mm x 5 mm
●	FF01-497/16-25	497 nm	> 90% over 16 nm	25 mm x 5 mm
●	FF01-500/15-25	500 nm	> 90% over 15 nm	25 mm x 5 mm
●	FF01-500/24-25	500 nm	> 93% over 24 nm	25 mm x 5 mm
●	FF01-504/12-25	504 nm	> 93% over 12 nm	25 mm x 5 mm
●	FF01-510/10-25	510 nm	> 90% over 10 nm	25 mm x 5 mm
●	FF02-510/20-25	510 nm	> 90% over 20 nm	25 mm x 5 mm
●	FF01-510/42-25	510 nm	> 90% over 42 nm	25 mm x 3.5 mm
●	FF01-510/84-25	510 nm	> 93% over 84 nm	25 mm x 3.5 mm
●	FF01-512/25-25	512 nm	> 92% over 25 nm	25 mm x 3.5 mm
●	FF01-513/17-25	513 nm	> 95% over 17 nm	25 mm x 3.5 nm
●	FF01-514/30-25	514 nm	> 93% over 30 nm	25 mm x 3.5 mm
●	FF01-517/20-25	517 nm	> 90% over 20 nm	25 mm x 5 mm <b>New!</b>
●	FF01-520/15-25	520 nm	> 90% over 15 nm	25 mm x 5 mm
●	FF01-520/28-25	520 nm	> 90% over 28 nm	25 mm x 5 mm <b>New!</b>
●	FF01-520/35-25	520 nm	> 93% over 35 nm	25 mm x 3.5 mm
●	FF01-523/20-25	523 nm	> 93% over 20 nm	25 mm x 3.5 mm
●	FF01-525/15-25	525 nm	> 90% over 15 nm	25 mm x 3.5 mm
●	FF01-525/20-25	525 nm	> 90% over 20 nm	25 mm x 3.5 mm
●	FF01-525/30-25	525 nm	> 90% over 30 nm	25 mm x 3.5 mm
●	FF01-525/39-25	525 nm	> 90% over 39 nm	25 mm x 3.5 mm
●	FF02-525/40-25	525 nm	> 90% over 40 nm	25 mm x 5 mm

<sup>[1]</sup> Bandwidth is the minimum width over which the average transmission exceeds the specified passband transmission; the nominal full-width-at-half-maximum (FWHM) is approximately the Bandwidth + 1% of the Center Wavelength.

(continued)

For graphs, ASCII data and blocking information, go to [www.semrock.com](http://www.semrock.com)



# BrightLine® Single-band Bandpass Filters (continued)

Extensive selection.  
Custom-sized filters are available in one week.

Passband Color	Filter	Center Wavelength	Avg. Transmission / Bandwidth [1]	Size (Diameter x Thickness)
●	FF01-525/45-25	525 nm	> 93% over 45 nm	25 mm x 3.5 mm
●	FF01-525/50-25	525 nm	> 90% over 50 nm	25 mm x 5 mm
●	FF01-527/20-25	527 nm	> 93% over 20 nm	25 mm x 3.5 mm
●	FF01-528/38-25	528 nm	> 90% over 38 nm	25 mm x 5 mm
●	FF01-529/24-25	529 nm	> 90% over 24 nm	25 mm x 5 mm
●	FF01-529/28-25	529 nm	> 90% over 28 nm	25 mm x 3.5 mm
●	FF01-530/11-25	530 nm	> 90% over 11 nm	25 mm x 5 mm
●	FF01-530/43-25	530 nm	> 90% over 43 nm	25 mm x 3.5 mm
●	FF01-530/200-25-D	530 nm	> 90% over 200 nm (UV/IR blocking filter)	25 mm x 3 mm (unmounted)
●	FF01-531/22-25	531 nm	> 90% over 22 nm	25 mm x 5 mm
●	FF01-531/40-25	531 nm	> 93% over 40 nm	25 mm x 5 mm
●	FF01-534/20-25	534 nm	> 93% over 20 nm	25 mm x 5 mm
●	FF01-534/30-25	534 nm	> 90% over 30 nm	25 mm x 5 mm
●	FF01-534/42-25	534 nm	> 90% over 42 nm	25 mm x 3.5 mm
●	FF01-535/22-25	535 nm	> 90% over 22 nm	25 mm x 3.5 mm
●	FF01-536/40-25	536 nm	> 93% over 40 nm	25 mm x 3.5 mm
●	FF01-537/26-25	537 nm	> 90% over 26 nm	25 mm x 5 mm
●	FF01-538/40-25	538 nm	> 90% over 40 nm	25 mm x 3.5 mm
●	FF01-540/15-25	540 nm	> 90% over 15 nm	25 mm x 5 mm
●	FF01-542/20-25	542 nm	> 90% over 20 nm	25 mm x 5 mm
●	FF01-542/27-25	542 nm	> 93% over 27 nm	25 mm x 3.5 mm
●	FF01-542/50-25	542 nm	> 93% over 50 nm	25 mm x 5 mm
●	FF01-543/22-25	543 nm	> 93% over 22 nm	25 mm x 5 mm
●	FF01-546/6-25	546 nm	> 90% over 6 nm	25 mm x 3.5 mm
●	FF01-549/15-25	549 nm	> 90% over 15 nm	25 mm x 3.5 mm <b>New!</b>
●	FF01-550/32-25	550 nm	> 90% over 32 nm	25 mm x 3.5 mm
●	FF01-550/49-25	550 nm	> 90% over 49 nm	25 mm x 3.5 mm <b>New!</b>
●	FF01-550/88-25	550 nm	> 92% over 88 nm	25 mm x 3.5 mm <b>New!</b>
●	FF01-554/211-25	554 nm	> 90% over 211 nm (UV/IR blocking filter)	25 mm x 5 mm
●	FF01-556/20-25	556 nm	> 93% over 20 nm	25 mm x 5 mm
●	FF01-558/20-25	558 nm	> 90% over 20 nm	25 mm x 5 mm <b>New!</b>
●	FF01-559/34-25	559 nm	> 90% over 34 nm	25 mm x 5 mm
●	FF01-560/14-25	560 nm	> 90% over 14 nm	25 mm x 5 mm
●	FF01-560/25-25	560 nm	> 93% over 25 nm	25 mm x 5 mm
●	FF01-561/4-25	561 nm	> 93% over 4 nm	25 mm x 5 mm
●	FF01-561/14-25	561 nm	> 93% over 14 nm	25 mm x 5 mm
●	FF01-562/40-25	562 nm	> 93% over 40 nm	25 mm x 5 mm
●	FF01-565/24-25	565 nm	> 90% over 24 nm	25 mm x 5 mm
●	FF01-567/15-25	567 nm	> 95% over 15 nm	25 mm x 3.5 mm
●	FF01-572/15-25	572 nm	> 92% over 15 nm	25 mm x 3.5 mm
●	FF01-572/28-25	572 nm	> 93% over 28 nm	25 mm x 3.5 mm
●	FF01-575/15-25	575 nm	> 90% over 15 nm	25 mm x 5 mm
●	FF01-575/25-25	575 nm	> 93% over 25 nm	25 mm x 5 mm
●	FF01-576/10-25	576 nm	> 90% over 10 nm	25 mm x 3.5 mm
●	FF01-578/16-25	578 nm	> 90% over 16 nm	25 mm x 5 mm <b>New!</b>
●	FF01-579/34-25	579 nm	> 90% over 34 nm	25 mm x 3.5 mm

[1] Bandwidth is the minimum width over which the average transmission exceeds the specified passband transmission; the nominal full-width-at-half-maximum (FWHM) is approximately the Bandwidth + 1% of the Center Wavelength.

(continued)

For graphs, ASCII data and blocking information, go to [www.semrock.com](http://www.semrock.com)

## BrightLine® Single-band Bandpass Filters (continued)

Every Semrock filter is hard-coated for *no burn-out* performance.  
Five-year warranty.

Passband Color	Filter	Center Wavelength	Avg. Transmission / Bandwidth [1]	Size (Diameter x Thickness)
●	FF01-580/14-25	580 nm	> 90% over 14 nm	25 mm x 5 mm
●	FF01-580/23-25	580 nm	> 90% over 23 nm	25 mm x 3.5 mm
●	FF01-580/60-25-D	580 nm	> 90% over 60 nm	25 mm x 4 mm (unmounted)
●	FF01-582/15-25	582 nm	> 90% over 15 nm	25 mm x 3.5 mm
●	FF01-582/75-25	582 nm	> 90% over 75 nm	25 mm x 5 mm
●	FF01-583/22-25	583 nm	> 92% over 22 nm	25 mm x 3.5 mm
●	FF01-583/120-25	583 nm	> 90% over 120 nm	25 mm x 3.5 mm
●	FF01-585/29-25	585 nm	> 90% over 29 nm	25 mm x 5 mm
●	FF01-585/40-25	585 nm	> 90% over 40 nm	25 mm x 3.5 mm
●	FF01-586/15-25	586 nm	> 90% over 15 nm	25 mm x 5 mm
●	FF01-586/20-25x3.5	586 nm	> 93% over 20 nm	25 mm x 3.5 mm
●	FF01-586/20-25x5	586 nm	> 93% over 20 nm	25 mm x 5 mm
●	FF01-587/11-25	587 nm	> 90% over 11 nm	25 mm x 5 mm
●	FF01-588/21-25	588 nm	> 90% over 21 nm	25 mm x 5 mm
●	FF01-589/15-25	589 nm	> 93% over 15 nm	25 mm x 5 mm
●	FF01-590/10-25	590 nm	> 90% over 10 nm	25 mm x 3.5 mm
●	FF01-590/20-25	590 nm	> 90% over 20 nm	25 mm x 5 mm
●	FF01-592/8-25	592 nm	> 93% over 8 nm	25 mm x 5 mm
●	FF01-593/40-25	593 nm	> 93% over 40 nm	25 mm x 3.5 mm
●	FF01-600/14-25	600 nm	> 90% over 14 nm	25 mm x 5 mm
●	FF01-605/15-25	605 nm	> 90% over 15 nm	25 mm x 3.5 mm
●	FF01-605/64-25	605 nm	> 90% over 64 nm	25 mm x 3.5 mm
●	FF01-607/36-25	607 nm	> 93% over 36 nm	25 mm x 3.5 mm
●	FF01-607/70-25	607 nm	> 92% over 70 nm	25 mm x 3.5 mm
●	FF01-609/54-25	609 nm	> 93% over 54 nm	25 mm x 3.5 mm
●	FF01-609/152-25	609 nm	> 93% over 152 nm	25 mm x 5 mm
●	FF01-615/20-25	615 nm	> 90% over 20 nm	25 mm x 5 mm
●	FF01-615/24-25	615 nm	> 90% over 24 nm	25 mm x 3.5 mm
●	FF01-617/73-25	617 nm	> 90% over 73 nm	25 mm x 5 mm
●	FF01-620/14-25	620 nm	> 90% over 14 nm	25 mm x 5 mm
●	FF01-620/52-25	620 nm	> 90% over 52 nm	25 mm x 3.5 mm
●	FF01-623/18-25	623 nm	> 90% over 18 nm	25 mm x 3.5 mm
●	FF01-624/40-25	624 nm	> 93% over 40 nm	25 mm x 3.5 mm
●	FF01-625/15-25	625 nm	> 90% over 15 nm	25 mm x 3.5 mm
●	FF01-625/26-25	625 nm	> 93% over 26 nm	25 mm x 5 mm
●	FF01-628/32-25	628 nm	> 93% over 32 nm	25 mm x 3.5 mm
●	FF01-628/40-25	628 nm	> 93% over 40 nm	25 mm x 5 mm
●	FF01-629/53-25	629 nm	> 90% over 53 nm	25 mm x 5 mm
●	FF01-629/56-25	629 nm	> 90% over 56 nm	25 mm x 3.5 mm
●	FF01-630/20-25	630 nm	> 90% over 20 nm	25 mm x 3.5 mm
●	FF01-630/69-25	630 nm	> 90% over 69 nm	25 mm x 3.5 mm
●	FF01-630/92-25	630 nm	> 92% over 92 nm	25 mm x 3.5 mm
●	FF01-632/22-25	632 nm	> 93% over 22 nm	25 mm x 5 mm
●	FF01-640/14-25	640 nm	> 90% over 14 nm	25 mm x 5 mm
●	LD01-640/8-25	640 nm	<i>See Laser Diode Clean-Up filters, page 65</i>	
●	FF01-641/75-25	641 nm	> 93% over 75 nm	25 mm x 3.5 mm

[1] Bandwidth is the minimum width over which the average transmission exceeds the specified passband transmission; the nominal full-width-at-half-maximum (FWHM) is approximately the Bandwidth + 1% of the Center Wavelength.

(continued)

# BrightLine® Single-band Bandpass Filters (continued)

Extensive selection.  
Custom-sized filters are available in one week.

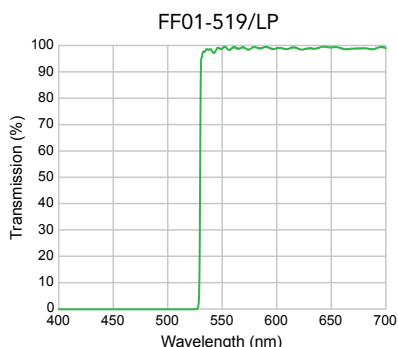
Passband Color	Filter	Center Wavelength	Avg. Transmission / Bandwidth <sup>[1]</sup>	Size (Diameter x Thickness)	
●	FF01-642/10-25	642 nm	> 93% over 10 nm	25 mm x 5 mm	
●	FF01-647/57-25	647 nm	> 92% over 57 nm	25 mm x 3.5 mm	
●	FF01-650/13-25	650 nm	> 93% over 13 nm	25 mm x 5 mm	
●	FF01-655/12-25	655 nm	> 90% over 12 nm	25 mm x 3.5 mm	
●	FF01-655/15-25	655 nm	> 90% over 15 nm	25 mm x 3.5 mm	
●	FF01-655/40-25	655 nm	> 93% over 40 nm	25 mm x 5 mm	
●	FF01-661/20-25	661 nm	> 90% over 20 nm	25 mm x 5 mm	<b>New!</b>
●	FF01-660/13-25	660 nm	> 90% over 13 nm	25 mm x 5 mm	
●	FF01-670/30-25	670 nm	> 95% over 30 nm	25 mm x 3.5 mm	
●	FF01-675/67-25	675 nm	> 90% over 67 nm	25 mm x 5 mm	
●	FF01-676/20-25	676 nm	> 90% over 20 nm	25 mm x 5 mm	<b>New!</b>
●	FF01-676/29-25	676 nm	> 90% over 29 nm	25 mm x 3.5 mm	
●	FF01-677/20-25	677 nm	> 90% over 20 nm	25 mm x 3.5 mm	
●	FF01-680/13-25	680 nm	> 90% over 13 nm	25 mm x 5 mm	
●	FF01-680/26-25	680 nm	> 92% over 26 nm	25 mm x 3.5 mm	
●	FF01-684/24-25	684 nm	> 90% over 24 nm	25 mm x 5 mm	
●	FF01-685/40-25	685 nm	> 90% over 40 nm	25 mm x 5 mm	
●	FF01-688/31-25	688 nm	> 90% over 31 nm	25 mm x 3.5 mm	
●	FF01-692/40-25	692 nm	> 93% over 40 nm	25 mm x 3.5 mm	
●	FF01-697/75-25-D	697 nm	> 90% over 75 nm	25 mm x 4 mm (unmounted)	
●	FF01-700/13-25	700 nm	> 90% over 13 nm	25 mm x 5 mm	
●	FF01-710/40-25	710 nm	> 93% over 40 nm	25 mm x 5 mm	<b>New!</b>
●	FF01-711/25-25	711 nm	> 90% over 25 nm	25 mm x 5 mm	<b>New!</b>
●	FF01-716/40-25	716 nm	> 93% over 40 nm	25 mm x 3.5 mm	
●	FF01-716/43-25	716 nm	> 90% over 43 nm	25 mm x 3.5 mm	
●	FF01-720/13-25	720 nm	> 90% over 13 nm	25 mm x 5 mm	
●	FF01-740/13-25	740 nm	> 90% over 13 nm	25 mm x 5 mm	
●	FF01-760/12-25	760 nm	> 90% over 12 nm	25 mm x 5 mm	
●	FF01-769/41-25	769 nm	> 93% over 41 nm	25 mm x 5 mm	
●	FF01-775/46-25	775 nm	> 93% over 46 nm	25 mm x 3.5 mm	
●	FF01-780/12-25	780 nm	> 90% over 12 nm	25 mm x 5 mm	
●	FF01-785/62-25	785 nm	> 94% over 62 nm	25 mm x 3.5 mm	
●	FF01-786/22-25	786 nm	> 93% over 22 nm	25 mm x 3.5 mm	
●	FF01-794/160-25	794 nm	> 93% over 160 nm	25 mm x 5 mm	
●	FF01-800/12-25	800 nm	> 90% over 12 nm	25 mm x 5 mm	
●	FF01-820/12-25	820 nm	> 90% over 12 nm	25 mm x 5 mm	
●	FF01-832/37-25	832 nm	> 93% over 37 nm	25 mm x 3.5 mm	
●	FF01-840/12-25	840 nm	> 90% over 12 nm	25 mm x 5 mm	
●	FF01-1055/6-25	1055 nm	> 90% over 6 nm	25 mm x 5 mm	<b>New!</b>
●	FF01-1060/13-25	1060 nm	> 90% over 13 nm	25 mm x 5 mm	<b>New!</b>
●	NIR01-1535/3-25	1535 nm	See Near-IR Bandpass Filters, page 69		<b>New!</b>
●	NIR01-1550/3-25	1550 nm	See Near-IR Bandpass Filters, page 69		<b>New!</b>
●	NIR01-1570/3-25	1570 nm	See Near-IR Bandpass Filters, page 69. If you require a different wavelength, please contact us.		<b>New!</b>

<sup>[1]</sup> Bandwidth is the minimum width over which the average transmission exceeds the specified passband transmission; the nominal full-width-at-half-maximum (FWHM) is approximately the Bandwidth + 1% of the Center Wavelength.

For graphs, ASCII data and blocking information, go to [www.semrock.com](http://www.semrock.com)

## BrightLine® Single-edge Filters

Every Semrock filter is hard-coated for *no burn-out* performance.  
Five-year warranty.



Semrock stocks an exceptional range of high-performance, high-reliability individual fluorescence edge filters that have been optimized for use in a variety of fluorescence instruments. These filters exclusively utilize our patented single-substrate construction for the highest performance and reliability. For additional offerings, see EdgeBasic™ long-wave-pass filters on page 58.

Unless otherwise noted, all filters are housed in a standard 25 mm round black-anodized aluminum ring with thickness as indicated, and a clear aperture of at least 21 mm. Parts with a "/LP" in the part number are long-wave-pass edge filters and parts with a "/SP" are short-wave-pass edge filters.

Edge Color	Filter	Edge Wavelength	Avg. Transmission / Bandwidth <sup>[1]</sup>	Size (Diameter x Thickness)
●	FF01-280/SP-25	276 nm	> 70% 270 - 275 nm	25 mm x 3.5 mm
●	FF01-300/LP-25	306 nm	> 85% 308 - 420 nm	25 mm x 5 mm
●	FF01-310/SP-25	293 nm	> 70% 270 - 290 nm	25 mm x 3.5 mm
●	FF01-341/LP-25	347 nm	> 90% 350 - 500 nm	25 mm x 3.5 mm
●	FF01-409/LP-25	416 nm	> 90% 419 - 700 nm	25 mm x 3.5 mm
●	FF01-492/SP-25	483 nm	> 90% 400 - 480 nm	25 mm x 5 mm
●	FF01-500/LP-25	515 nm	> 90% 519 - 700 nm	25 mm x 3.5 mm
●	FF01-518/SP-25	488 nm	> 90% 445 - 485 nm	25 mm x 3.5 mm
●	FF01-519/LP-25	530 nm	> 92% 534 - 653 nm	25 mm x 3.5 mm
●	FF01-676/LP-25	792 nm	> 95% 805 - 877 nm	25 mm x 5 mm
●	FF01-680/SP-25	654 nm	<i>See Multiphoton filters, page 35</i>	
●	FF01-694/SP-25	681 nm	> 93% 481 - 676 nm	25 mm x 3.5 mm
●	FF01-720/SP-25	696 nm	<i>See Multiphoton filters, page 35</i> <b>New!</b>	
●	FF01-736/LP-25	754 nm	> 90% 761 - 850 nm	25 mm x 3.5 mm
●	FF01-750/SP-25	727 nm	<i>See Multiphoton filters, page 35</i>	
●	FF01-775/SP-25	761 nm	> 93% 481 - 756 nm	25 mm x 3.5 mm
●	FF01-800/LP-25	812 nm	> 90% 815 - 915 nm	25 mm x 3.5 mm
●	FF01-834/LP-25	840 nm	> 97% 842 - 935 nm	25 mm x 3.5 mm
●	FF01-835/LP-25	848 nm	> 93% 850 - 950 nm	25 mm x 3.5 mm <b>New!</b>
●	FF01-842/SP-25	835 nm	> 95% 485 - 831 nm	25 mm x 3.5 mm
●	FF01-945/SP-25	938 nm	> 90% 600 - 923 nm	25 mm x 3.5 mm <b>New!</b>

For graphs, ASCII data and blocking information, go to [www.semrock.com](http://www.semrock.com)

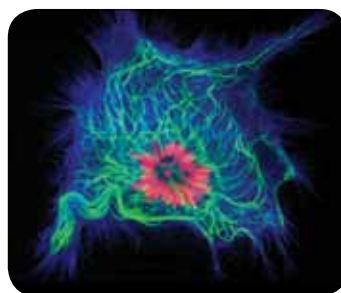


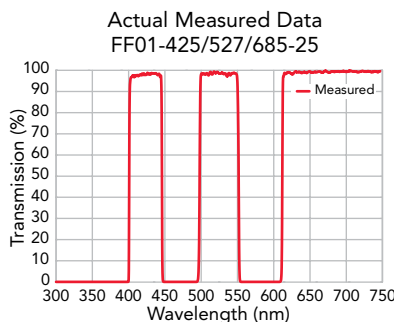
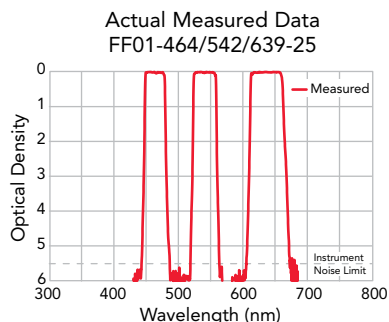
Image courtesy of Mike Davidson at Molecular Expressions™, using BrightLine® fluorescence filter sets.

# BrightLine® Multiband Bandpass Filters

Extensive selection.

Custom-sized filters are available in one week.

Semrock offers a unique selection of individual high-performance multiband fluorescence bandpass filters that have been optimized for use in a variety of fluorescence instruments. These filters all utilize our exclusively single-substrate, low-autofluorescence glass construction. All filters are housed in a standard 25 mm round black-anodized aluminum ring with thickness as indicated, and have a clear aperture of at least 21 mm. These filters have extremely high transmission, steep and well-defined edges, and outstanding blocking between the passbands. Examples of triple-band filters FF01-464/542/639-25 and FF01-425/527/685-25 are shown below. See page 74 for a Technical Note on optical density.



Center Wavelength	Avg. Transmission / Bandwidth <sup>[1]</sup>	Size (Diameter x Thickness)	Filter Part Number
<b>Dual-band Filters</b>			
387 nm 480 nm	> 80% over 11 nm > 90% over 29 nm	25 mm x 5 mm	FF01-387/480-25 <b>New!</b>
416 nm 501 nm	> 90% over 25 nm > 90% over 18 nm	25 mm x 5 mm	FF01-416/501-25
433 nm 530 nm	> 90% over 38 nm > 90% over 40 nm	25 mm x 3.5 mm	FF01-433/530-25 <b>New!</b>
445 nm 509 nm	> 90% over 20 nm > 90% over 12 nm	25 mm x 5 mm	FF01-445/509-25 <b>New!</b>
448 nm 523 nm	> 90% over 55 nm > 90% over 47 nm	25 mm x 5 mm	FF01-448/523-25
464 nm 547 nm	> 90% over 23 nm > 90% over 31 nm	25 mm x 3.5 mm	FF01-464/547-25
468 nm 553 nm	> 90% over 34 nm > 90% over 24 nm	25 mm x 5 mm	FF01-468/553-25
470 nm 556 nm	> 90% over 21 nm > 90% over 19 nm	25 mm x 5 mm	FF01-470/556-25 <b>New!</b>
477 nm 522 nm	> 90% over 45 nm > 90% over 35 nm	25 mm x 5 mm	FF01-477/522-25
479 nm 585 nm	> 90% over 38 nm > 90% over 27 nm	25 mm x 5 mm	FF01-479/585-25
480 nm 593 nm	> 90% over 10 nm > 90% over 120 nm	25 mm x 3.5 mm	FF01-480/593-25
482 nm 563 nm	> 93% over 18 nm > 93% over 9 nm	25 mm x 5 mm	FF01-482/563-25 <b>New!</b>
494 nm 576 nm	> 90% over 20 nm > 90% over 20 nm	25 mm x 5 mm	FF01-494/576-25
503 nm 572 nm	> 90% over 18 nm > 90% over 18 nm	25 mm x 5 mm	FF01-503/572-25
507 nm 582 nm	> 90% over 15 nm > 90% over 55 nm	25 mm x 5 mm	FF01-507/582-25
508 nm 585 nm	> 90% over 26 nm > 90% over 72 nm	25 mm x 5 mm	FF01-508/585-25
512 nm 630 nm	> 90% over 23 nm > 90% over 91 nm	25 mm x 3.5 mm	FF01-512/630-25

<sup>[1]</sup> Bandwidth is the minimum width over which the average transmission exceeds the specified passband transmission; the nominal full-width-at-half-maximum (FWHM) is approximately the Bandwidth + 1% of the Center Wavelength.

(continued)

For graphs, ASCII data and blocking information, go to [www.semrock.com](http://www.semrock.com)

# BrightLine® Multiband Bandpass Filters (continued)

Every Semrock filter is hard-coated for *no burn-out* performance.

Five-year warranty.

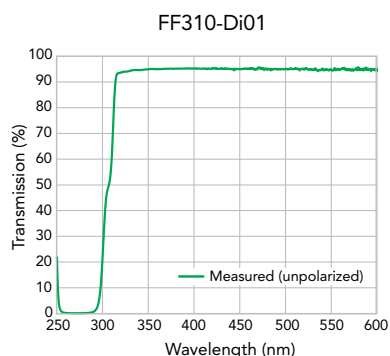
Center Wavelength	Avg. Transmission / Bandwidth <sup>[1]</sup>	Size (Diameter x Thickness)	Filter Part Number	
523 nm 610 nm	> 93% over 40 nm > 93% over 52 nm	25 mm x 3.5 mm	FF01-523/610-25	<b>New!</b>
524 nm 628 nm	> 90% over 29 nm > 90% over 33 nm	25 mm x 3.5 mm	FF01-524/628-25	
527 nm 645 nm	> 90% over 42 nm > 90% over 49 nm	25 mm x 3.5 mm	FF01-527/645-25	
534 nm 635 nm	> 90% over 36 nm > 90% over 31 nm	25 mm x 5 mm	FF01-534/635-25	
535 nm 675 nm	> 90% over 70 nm > 90% over 50 nm	25 mm x 5 mm	FF01-535/675-25	<b>New!</b>
538 nm 685 nm	> 90% over 50 nm > 90% over 45 nm	25 mm x 3.5 mm	FF01-538/685-25	
577 nm 690 nm	> 90% over 24 nm > 90% over 50 nm	25 mm x 3.5 mm	FF01-577/690-25	
594 nm 730 nm	> 90% over 42 nm > 90% over 140 nm	25 mm x 5 mm	FF01-594/730-25	
Triple-band Filters				
387 nm 478 nm 555 nm	> 80% over 11 nm > 90% over 24 nm > 90% over 19 nm	25 mm x 5 mm	FF01-387/478/555-25	<b>New!</b>
407 nm 494 nm 576 nm	> 80% over 14 nm > 85% over 20 nm > 85% over 20 nm	25 mm x 5 mm	FF01-407/494/576-25	
422 nm 503 nm 572 nm	> 90% over 30 nm > 90% over 18 nm > 90% over 18 nm	25 mm x 5 mm	FF01-422/503/572-25	
425 nm 527 nm 685 nm	> 90% over 35 nm > 90% over 42 nm > 90% over 130 nm	25 mm x 3.5 mm	FF01-425/527/685-25	
433 nm 517 nm 613 nm	> 90% over 36 nm > 90% over 23 nm > 90% over 61 nm	25 mm x 3.5 mm	FF01-433/517/613-25	<b>New!</b>
457 nm 530 nm 628 nm	> 80% over 22 nm > 85% over 20 nm > 85% over 28 nm	25 mm x 3.5 mm	FF01-457/530/628-25	
464 nm 542 nm 639 nm	> 90% over 23 nm > 90% over 27 nm > 90% over 42 nm	25 mm x 3.5 mm	FF01-464/542/639-25	
465 nm 537 nm 623 nm	> 90% over 30 nm > 90% over 20 nm > 90% over 50 nm	25 mm x 3.5 mm	FF01-465/537/623-25	
480 nm 535 nm 610 nm	> 90% over 40 nm > 90% over 21 nm > 90% over 80 nm	25 mm x 3.5 mm	FF01-480/535/610-25	
480 nm 546 nm 685 nm	> 90% over 10 nm > 90% over 22 nm > 90% over 130 nm	25 mm x 3.5 mm	FF01-480/546/685-25	
Quadruple-band Filters				
390 nm 482 nm 563 nm 640 nm	> 85% over 40 nm > 90% over 18 nm > 90% over 9 nm > 90% over 14 nm	25 mm x 5 mm	FF01-390/482/563/640-25	<b>New!</b>
440 nm 521 nm 607 nm 700 nm	> 90% over 40 nm > 90% over 21 nm > 90% over 34 nm > 90% over 45 nm	25 mm x 3.5 mm	FF01-440/521/607/700-25	
446 nm 523 nm 600 nm 677 nm	> 90% over 32.5 nm > 90% over 42 nm > 90% over 35.5 nm > 90% over 27.5 nm	25 mm x 3.5 mm	FF01-446/523/600/677-25	<b>New!</b>

<sup>[1]</sup> Bandwidth is the minimum width over which the average transmission exceeds the specified passband transmission; the nominal full-width-at-half-maximum (FWHM) is approximately the Bandwidth + 1% of the Center Wavelength.

# BrightLine® Single-edge Dichroic Beamsplitters

Extensive selection.

Custom-sized filters are available in one week.



Semrock offers a wide range of polarization-insensitive dichroic beamsplitters that exhibit steep edges with very high and flat reflection and transmission bands. More complete reflection and transmission mean less stray light for lower background and improved signal-to-noise ratio. These filters are optimized for fluorescence microscopes and instrumentation, and may also be used for a variety of other applications that require beam combining and separation based on wavelength. All Semrock filters are made with our reliable hard-coating technology. Our dichroics utilize high-optical-quality, ultralow-auto-fluorescence glass substrates. These filters are excellent for epifluorescence. For TIRF and diverse laser applications, see page 48.

## Single-edge General Purpose Dichroic Beamsplitters (polarization-insensitive; for use at 45°)

Most beamsplitters are long-wave-pass (LWP) filters (reflect shorter wavelengths and transmit longer wavelengths).

Short-wave-pass (SWP) beamsplitters (SDi01) are indicated in the special features column.

Edge Color	Nominal Edge Wavelength	Avg. Reflection Band <sup>[1]</sup>	Avg. Transmission Band <sup>[1]</sup>	Special Features	Size (L x W x H or Diameter x Thickness)	Filter Part Number
●	310 nm	255 – 295 nm	315 – 600 nm		25.2 mm x 35.6 mm x 1.1 mm	FF310-Di01-25x36
●	409 nm	344 – 404 nm	415 – 570 nm		25.2 mm x 35.6 mm x 1.1 mm	FF409-Di02-25x36
●	458 nm	426 – 450 nm	467 – 600 nm		25.2 mm x 35.6 mm x 1.1 mm	FF458-Di01-25x36
●	472 nm	485 – 493 nm	400 – 464 nm	short-wave-pass	25.2 mm x 35.6 mm x 1.1 mm	FF472-SDi01-25x36
●	493 nm	445 – 485 nm	505 – 690 nm		25.2 mm x 35.6 mm x 2.0 mm	FF493-Di01-25x36x2.0 <b>New!</b>
●	495 nm	442 – 488 nm	502 – 730 nm		25.2 mm x 35.6 mm x 1.1 mm	FF495-Di02-25x36
●	500 nm	485 – 491 nm	510 – 825 nm		25.2 mm x 35.6 mm x 1.1 mm	FF500-Di01-25x36
●	505 nm	513 – 725 nm	446 – 500 nm	short-wave-pass	25.2 mm x 35.6 mm x 1.1 mm	FF505-SDi01-25x36
●	506 nm	446 – 500 nm	513 – 725 nm		25.2 mm x 35.6 mm x 1.1 mm	FF506-Di02-25x36
●	510 nm	327 – 488 nm	515 – 850 nm		25.2 mm x 35.6 mm x 1.1 mm	FF510-Di01-25x36
●	511 nm	400 – 495 nm	525 – 800 nm		25.2 mm x 35.6 mm x 1.1 mm	FF511-Di01-25x36 <b>New!</b>
●	520 nm	488 – 512 nm	528 – 655 nm		25.2 mm x 35.6 mm x 1.1 mm	FF520-Di01-25x36
●	535 nm	490 – 528 nm	547 – 690 nm		25.2 mm x 35.6 mm x 2.0 mm	FF535-Di01-25x36x2.0 <b>New!</b>
●	541 nm	570 – 710 nm	500 – 530 nm	short-wave-pass	25.2 mm x 35.6 mm x 1.1 mm	FF541-SDi01-25x36
●	550 nm	509 – 537 nm	559 – 850 nm		25.0 mm x 2.0 mm (unmounted)	FF550-Di01-25x2.0-D
●	552 nm	524 – 544 nm	558 – 725 nm		25.2 mm x 35.6 mm x 1.1 mm	FF552-Di01-25x36
●	555 nm	493 – 548 nm	562 – 745 nm		25.2 mm x 35.6 mm x 1.1 mm	FF555-Di02-25x36
●	560 nm	485 – 545 nm	570 – 825 nm		25.2 mm x 35.6 mm x 1.1 mm	FF560-Di01-25x36
●	562 nm	499 – 555 nm	569 – 730 nm		25.2 mm x 35.6 mm x 1.1 mm	FF562-Di02-25x36
●	565 nm	530 – 558 nm	578 – 690 nm		25.2 mm x 35.6 mm x 2.0 mm	FF565-Di01-25x36x2.0 <b>New!</b>
●	568 nm	405 – 555 nm	575 – 650 nm		25.2 mm x 35.6 mm x 1.1 mm	FF568-Di01-25x36 <b>New!</b>
●	591 nm	601 – 800 nm	530 – 585 nm	short-wave-pass	25.2 mm x 35.6 mm x 1.1 mm	FF591-SDi01-25x36
●	593 nm	530 – 585 nm	601 – 800 nm		25.2 mm x 35.6 mm x 1.1 mm	FF593-Di02-25x36
●	599 nm	567 – 585 nm	609 – 850 nm		25.0 mm x 2.0 mm (unmounted)	FF599-Di01-25x2.0-D
●	605 nm	576 – 596 nm	612 – 725 nm		25.2 mm x 35.6 mm x 1.1 mm	FF605-Di01-25x36
●	648 nm	400 – 629 nm	658 – 700 nm		25.2 mm x 35.6 mm x 1.1 mm	FF648-Di01-25x36
●	650 nm	500 – 640 nm	660 – 825 nm		25.2 mm x 35.6 mm x 1.1 mm	FF650-Di01-25x36

<sup>[1]</sup> Wavelength ranges over which average reflection and transmission are guaranteed to be above 98% and 90%, respectively.

(continued)

For graphs & ASCII data, go to [www.semrock.com](http://www.semrock.com)

# BrightLine® Single-edge Dichroic Beamsplitters

Every Semrock filter is hard-coated for *no burn-out* performance.  
Five-year warranty.

## Single-edge Dichroic Beamsplitters (continued)

Edge Color	Nominal Edge Wavelength	Avg. Reflection Band [1]	Avg. Transmission Band [1]	Special Features	Size (L x W x H or Diameter x Thickness)	Filter Part Number	
●	655 nm	470 – 645 nm	665 – 726 nm		25.2 mm x 35.6 mm x 1.1 mm	FF655-Di01-25x36	
●	660 nm	594 – 651 nm	669 – 726 nm		25.2 mm x 35.6 mm x 1.1 mm	FF660-Di01-25x36	
●	665 nm	See Multiphoton Filters, page 35					FF665-Di02-25x36
●	669 nm	350 – 660 nm	677 – 800 nm		25.2 mm x 35.6 mm x 3.0 mm	FF669-Di01-25x36x3.0	
●	670 nm	short-wave-pass; See Multiphoton Filters, page 35					FF670-SDi01-25x36
●	677 nm	400 – 658 nm	687 – 830 nm		25.2 mm x 35.6 mm x 1.1 mm	FF677-Di01-25x36	
●	685 nm	600 – 676 nm	695 – 810 nm		25.2 mm x 35.6 mm x 1.1 mm	FF685-Di01-25x36	
●	705 nm	See Multiphoton Filters, page 35					FF705-Di01-25x36 <b>New!</b>
●	709 nm	661 – 692 nm	720.5 – 850 nm		25.0 mm x 2.0 mm (unmounted)	FF709-Di01-25x2.0-D	
●	721 nm	805 – 877 nm	668 – 674 nm	short-wave-pass	25.2 mm x 35.6 mm x 1.1 mm	FF721-SDi01-25x36	
●	731 nm	625 – 710 nm	742 – 850 nm		25.2 mm x 35.6 mm x 1.1 mm	FF731-Di01-25x36	
●	735 nm	See Multiphoton Filters, page 35					FF735-Di01-25x36
●	740 nm	480 – 720 nm	750 – 825 nm		25.2 mm x 35.6 mm x 1.1 mm	FF740-Di01-25x36	
●	741 nm	660 – 731.5 nm	750.5 – 810 nm		25.2 mm x 35.6 mm x 1.1 mm	FF741-Di01-25x36	
●	750 nm	770 – 920 nm	450 – 730 nm	short-wave-pass	25.2 mm x 35.6 mm x 2.0 mm	FF750-SDi01-25x36x2.0	
●	801 nm	749 – 790 nm	813.5 – 885 nm		25.2 mm x 35.6 mm x 1.1 mm	FF801-Di01-25x36	

[1] Wavelength ranges over which average reflection and transmission are guaranteed to be above 98% and 90%, respectively.

## Image Splitting Dichroic Beamsplitters **New!**

These beamsplitters offer superb image quality for both transmitted and reflected light when separating beams of light by color for simultaneous capture of multiple images. For applications such as Fluorescence Resonance Energy Transfer (FRET) and real-time live-cell imaging, users can now separate two, four or even more colors onto as many cameras or regions of a single camera sensor. The exceptional flatness of these filters virtually eliminates aberrations in the reflected beam for most common imaging systems (see *Technical Note on page 47*)

Nominal Edge Wavelength	Common Fluorophore Pairs to Split	Average Reflection Band	Average Transmission Band	Size (L x W x H)	Filter Part Number
484 nm	DAPI/FITC (or BFP/GFP)	350 – 475 nm	492 – 950 nm	25.5 mm x 35.6 mm x 1.1 mm	FF484-FDi01-25x36 <b>New!</b>
509 nm	CFP/YFP	350 – 500 nm	518 – 950 nm	25.5 mm x 35.6 mm x 1.1 mm	FF509-FDi01-25x36 <b>New!</b>
580 nm	GFP/mCherry (or FITC/TxRed)	350 – 570 nm	591 – 950 nm	25.5 mm x 35.6 mm x 1.1 mm	FF580-FDi01-25x36 <b>New!</b>
662 nm	Cy3/Cy5 (or TxRed/Cy5)	350 – 650 nm	674 – 950 nm	25.5 mm x 35.6 mm x 1.1 mm	FF662-FDi01-25x36 <b>New!</b>

## Image Splitting Dichroic Beamsplitters Common Specifications

Property	Value	Comment
Transmission	> 93%	Averaged over the specified band
Reflection	> 95%	Averaged over the specified band
Flatness	< $\lambda / 4$ Peak-to-valley at $\lambda = 633$ nm	Spherical error measured over a 10 mm aperture <sup>[1]</sup>

[1] A 10 mm spot size in typical assuming common microscope values. See [www.semrock.com](http://www.semrock.com).

All other mechanical specifications are the same as BrightLine dichroic specifications on page 34.

For graphs, ASCII data and blocking information, go to [www.semrock.com](http://www.semrock.com)



## TECHNICAL NOTE

### Flatness of Dichroic Beamsplitters Affects Focus and Image Quality

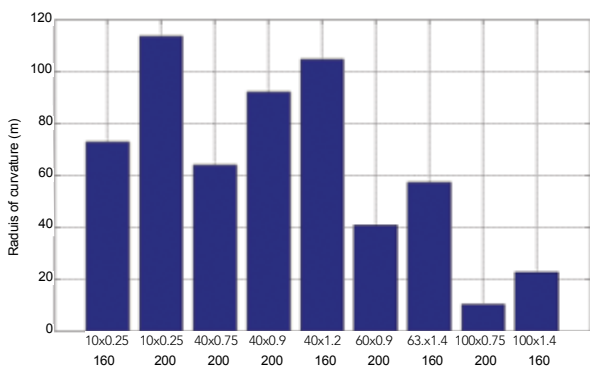
Optical filters are generally comprised of multi-layered thin-film coatings on plane, parallel glass substrates. All Semrock filters use a single substrate with coatings on one or both sides to maximize transmission and reliability and minimize artifacts associated with multiple interfaces. The glass substrate is not always perfectly flat, especially after it is coated, sometimes resulting in a slight bending of the substrate. Fortunately, this bending has no noticeable effect on light transmitted through an optical filter at or near normal incidence. For light incident at high angles of incidence, as is the case for a 45° dichroic beamsplitter, the only effect of a bent substrate on transmitted light is a slight divergence of the beam axis.

However, a bent filter substrate can have noticeable impact on reflected light. Examples include an excitation beam reflected off of a dichroic before impinging on a sample object, or an imaging beam that is split into two colors using a dichroic. Two main effects may occur: the position of the focal plane shifts and the size of the focused spot or the quality of the image is compromised.

Often a small shift of the focal plane is not a problem, because a lens or camera adjustment can be made to compensate. But in some cases the focal shift may be too large to compensate – focusing a laser beam onto the back focal plane of the objective in a Total Internal Reflection Fluorescence (TIRF) microscope, or imaging the grid onto the sample plane in a structured illumination microscope represent cases where care should be taken to use a flat dichroic, such as those designed for laser applications (for example, see page 48).

When light incident at 45° is reflected off of a dichroic with a slight bend, the resulting optical aberrations (such as astigmatism) can degrade the quality of an image after an imaging lens. As an example, the graph on the right shows the spot size at an image plane that results from a perfect point source after reflecting off of a dichroic with various radii of curvature.

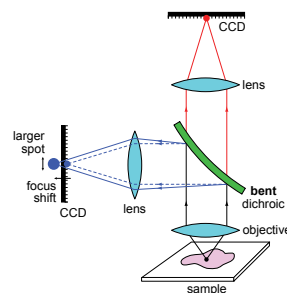
This plot is based on a typical epifluorescence microscope configuration, assuming a perfect point source at the sample location, imaged onto the image plane (e.g., CCD surface) by an ideal 40X, 0.75 NA objective and a tube lens with a 200 mm typical focal length (industry standard tube length focal lengths range between 160 and 200 mm). The resulting beam diameter is 6.75 mm. The reflection off of the dichroic is assumed to occur mid-way between the objective and the tube lens. The field of view of the system is assumed to be limited by a 20 mm diameter field size at the camera plane. The light is assumed to have a wavelength of 510 nm (peak of GFP emission). For comparison, the diffraction-limited spot size that would result from a perfect objective and tube lens and a perfectly flat dichroic is 16.6 μm (red line on plot).



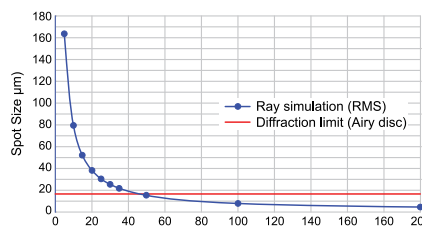
Desired radii of curvature of dichroics suitable for image splitting applications for a number of common microscope objectives. Each objective is labeled with its magnification, numerical aperture (NA), and associated tube lens focal length (in mm).

the image plane can be appreciably larger than the diffraction-limited spot size in an actual system. Nevertheless, care should be taken to select properly optimized, flatter dichroic beamsplitters when working with reflected light. Dichroics designed to reflect laser light ("laser dichroics," see pages 48 and 51) are generally flat enough to ensure negligible focal shift for laser beams up to several mm in diameter. Dichroics designed to reflect imaging beams ("imaging dichroics", see page 46) have the most extreme flatness requirements, since they must effectively eliminate the effects of astigmatism for beams as large as 1 cm or more.

For additional information on this topic visit our website: [www.semrock.com/TechnicalInformation/WhitePapers/](http://www.semrock.com/TechnicalInformation/WhitePapers/)



A bent dichroic can introduce aberrations.



Dichroic's radius of curvature affects spot size.

A sufficient criterion for an imaging beam (i.e., focused onto a detector array such as a CCD) reflected off a dichroic, is that the diffraction-limited spot size should not change appreciably due to reflection off of the beamsplitter. The required minimum radius of curvature for a number of objective-tube lens combinations (with standard tube lenses) that are common in fluorescence microscopes are summarized in the following figure. The required minimum radii vary from a few tens of meters for the higher magnification objectives (with smaller beam diameter) to as high as about 50 to 100 meters for the lower magnification objectives (with larger beam diameter).

While reflected image quality can be worse than the ideal diffraction-limited response for dichroics that are not perfectly flat, it should be noted that the true spot size at

# BrightLine® Single-edge Laser Dichroic Beamsplitters

Every Semrock filter is hard-coated for *no burn-out* performance.  
Five-year warranty.

These dichroic beamsplitters are optimized for the most popular lasers used for fluorescence imaging, including newer all-solid-state lasers. Reflection is guaranteed to be > 98% (s-polarization) and > 94% (average polarization) at the laser wavelengths, plus > 93% average transmission and very low ripple over extremely wide passbands – out to 900 and even 1200 nm.

**Laser Dichroic Beamsplitters** (*polarization-insensitive; for use at 45°*)  
For multiedge laser-optimized dichroic beamsplitters, see page 51.

**These items ship same day!**

Nominal Edge Wavelength	Laser Wavelengths	Reflection Band	Avg. Transmission Band	Size (L x W x H)	Filter Part Number
415 nm	375 ± 3 nm 405 ± 5 nm	372.0 – 410.0 nm	420.3 – 900.0 nm	25.2 mm x 35.6 mm x 1.1 mm	Di01-R405-25x36
463 nm	440 +3/-1 nm 442.0 nm 457.9 nm	439.0 – 457.9 nm	469.3 – 900.0 nm	25.2 mm x 35.6 mm x 1.1 mm	Di01-R442-25x36 <b>New!</b>
497 nm	473 ± 2 nm 488 +3/-2 nm	471.0 – 491.0 nm	503.3 – 900.0 nm	25.2 mm x 35.6 mm x 1.1 mm	Di01-R488-25x36
521 nm	505.0 nm 514.5 nm 515.0 nm	505.0 – 515.0 nm	527.9 – 900.0 nm	25.2 mm x 35.6 mm x 1.1 mm	Di01-R514-25x36 <b>New!</b>
542 nm	514.5 nm 532 nm	514.0 – 532.0 nm	545.3 – 1200.0 nm	25.2 mm x 35.6 mm x 1.1 mm	Di01-R532-25x36
575 nm	559 ± 5 nm 561.4 nm 568.2 nm	554.0 – 568.2 nm	582.4 – 1200.0 nm	25.2 mm x 35.6 mm x 1.1 mm	Di01-R561-25x36
654 nm	632.8 nm 635 +7/-0 nm 647.1 nm	632.8 – 647.1 nm	663.3 – 1200.0 nm	25.2 mm x 35.6 mm x 1.1 mm	Di01-R635-25x36

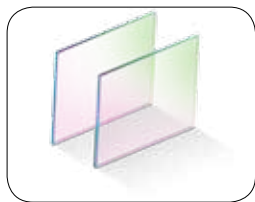
For graphs & ASCII data, go to [www.semrock.com](http://www.semrock.com)

## Laser Dichroic Beamsplitters Common Specifications

Property	Value	Comment
Reflection	> 98% (s-polarization) > 90% (p-polarization) > 94% (average polarization)	Absolute reflectivity over the specified laser wavelengths/bands
Transmission	> 93%	Averaged over the transmission band above
Angle of Incidence	45.0°	Range for above optical specifications Based on a collimated beam of light
Dependence of Wavelength on Angle of Incidence (Edge Shift)	0.35% / degree	Linear relationship valid between about 40°- 50°
Cone Half Angle (for non-collimated light)	< 0.5°	Rays uniformly distributed and centered at 45°
Transmitted Wavefront Error	< $\lambda / 4$ RMS at $\lambda = 633$ nm	Peak-to-valley error < 5 x RMS
Beam Deviation	≤ 10 arc seconds	
Second Surface	Anti-reflection (AR) coated	
Flatness	Reflection of a collimated, gaussian laser beam with waist diameter up to 2.5 mm causes less than one Rayleigh Range of focal shift after the objective or a focusing lens.	
Reliability and Durability	Ion-beam-sputtered, hard-coated technology with epoxy-free, single-substrate construction for unrivaled filter life and no “burn-out” even when subjected to high optical intensities for a prolonged period of time. BrightLine filters are rigorously tested and proven to MIL-STD-810F and MIL-C-48497A environmental standards.	
Filter Orientation	Reflective coating side should face toward light source and sample ( <i>see page 33</i> )	
Microscope Compatibility	BrightLine filters are available to fit Leica, Nikon, Olympus, and Zeiss microscopes.	

All other mechanical specifications are the same as BrightLine dichroic specifications on page 34.

# BrightLine® Multiedge Dichroic Beamsplitters



Extensive selection.  
Custom-sized filters are available in one week.

## Dual-edge General Purpose Dichroic Beamsplitters (polarization-insensitive; for use at 45°)

For laser-optimized fluorescence dichroic beamsplitters, see page 51.

Nominal Edge Wavelength	Reflection Bands <sup>(1)</sup>	Transmission Bands <sup>(1)</sup>	Special Features	Size (L x W x H)	Filter Part Number	
403 nm 502 nm	370 – 393 nm 466 – 495 nm	414 – 452 nm 510 – 550 nm		25.2 mm x 35.6 mm x 1.1 mm	FF403/502-Di01-25x36x2.0	<b>New!</b>
440 nm 520 nm	415 – 432 nm 493 – 511 nm	449 – 483 nm 530 – 569 nm		25.2 mm x 35.6 mm x 1.1 mm	FF440/520-Di01-25x36	
462 nm 523 nm	430 – 453 nm 508 – 512 nm	471 – 489 nm 534 – 650 nm		25.2 mm x 35.6 mm x 1.1 mm	FF462/523-Di01-25x36	
483 nm 639 nm	390 – 460 nm 565 – 625 nm	490 – 548 nm 644 – 790 nm		25.2 mm x 35.6 mm x 1.1 mm	FF483/639-Di01-25x36	<b>New!</b>
493 nm 574 nm	456 – 480 nm 541 – 565 nm	500 – 529 nm 584 – 679 nm		25.2 mm x 35.6 mm x 1.1 mm	FF493/574-Di01-25x36	
502 nm 670 nm	350 – 494 nm 641 – 660 nm	505 – 621 nm 677 – 800 nm		25.2 mm x 35.6 mm x 3.0 mm	FF502/670-Di01-25x36x3.0	
505 nm 606 nm	458 – 499 nm 570 – 600 nm	509 – 541 nm 612 – 647 nm		25.2 mm x 35.6 mm x 1.1 mm	FF505/606-Di01-25x36	
545 nm 650 nm	532.0 nm 632.8 nm	554 – 613 nm 658 – 742 nm		25.2 mm x 35.6 mm x 1.1 mm	FF545/650-Di01-25x36	
560 nm 659 nm	514 – 553 nm 617 – 652 nm	564 – 591 nm 665 – 718 nm		25.2 mm x 35.6 mm x 1.1 mm	FF560/659-Di01-25x36	

<sup>(1)</sup> Wavelength ranges over which average reflection and transmission are guaranteed to be above 95% and 90%, respectively.

## Narrow Notch Beamsplitters - notches keyed to popular laser lines (polarization-insensitive; for use at 45°)

Nominal Edge Wavelength	Reflection Bands <sup>(1)</sup>	Transmission Bands <sup>(1)</sup>	Special Features	Size (L x W x H)	Filter Part Number
495 nm 605 nm	454 – 485 nm 570 – 598 nm	505 – 550 nm 620 – 675 nm	Designed for dual-laser excitation (532 and 633 nm) of Cy3 and Cy5	25.2 mm x 35.6 mm x 1.1 mm	FF495/605-Di01-25x36
497 nm 554 nm	486 – 490 nm 542 – 544 nm	420 – 471 nm 505 – 525 nm 561 – 700 nm	Reflects laser wavelengths 488 nm and 543 nm	25.2 mm x 35.6 mm x 1.1 mm	FF497/554-Di01-25x36
497 nm 661 nm	486 – 490 nm 646 – 648 nm	420 – 471 nm 505 – 626 nm 668 – 750 nm	Reflects laser wavelengths 488 nm and 647 nm	25.2 mm x 35.6 mm x 1.1 mm	FF497/661-Di01-25x36
498 nm 581 nm	486 – 490 nm 567 – 569 nm	420 – 471 nm 505 – 549 nm 587 – 700 nm	Reflects laser wavelengths 488 nm and 568 nm	25.2 mm x 35.6 mm x 1.1 mm	FF498/581-Di01-25x36
500 nm 646 nm	486 – 490 nm 632 – 634 nm	420 – 471 nm 505 – 613 nm 653 – 750 nm	Reflects laser wavelengths 488 nm and 633 nm	25.2 mm x 35.6 mm x 1.1 mm	FF500/646-Di01-25x36
553 nm 659 nm	542 – 544 nm 646 – 648 nm	420 – 525 nm 561 – 626 nm 668 – 750 nm	Reflects laser wavelengths 543 nm and 647 nm	25.2 mm x 35.6 mm x 1.1 mm	FF553/659-Di01-25x36
555 nm 646 nm	542 – 544 nm 632 – 634 nm	420 – 525 nm 561 – 613 nm 653 – 750 nm	Reflects laser wavelengths 543 nm and 633 nm	25.2 mm x 35.6 mm x 1.1 mm	FF555/646-Di01-25x36
576 nm 661 nm	567 – 569 nm 646 – 648 nm	420 – 549 nm 587 – 626 nm 668 – 750 nm	Reflects laser wavelengths 568 nm and 647 nm	25.2 mm x 35.6 mm x 1.1 mm	FF576/661-Di01-25x36
579 nm 644 nm	567 – 569 nm 632 – 634 nm	420 – 549 nm 587 – 613 nm 653 – 750 nm	Reflects laser wavelengths 568 nm and 633 nm	25.2 mm x 35.6 mm x 1.1 mm	FF579/644-Di01-25x36

<sup>(1)</sup> Wavelength ranges over which average reflection and transmission are guaranteed to be above 95% and 90%, respectively.

For graphs & ASCII data, go to [www.semrock.com](http://www.semrock.com)

[www.semrock.com](http://www.semrock.com) [semrock@idexcorp.com](mailto:semrock@idexcorp.com) 1-866-SEMROCK

# BrightLine® Multiedge Dichroic Beamsplitters

Every Semrock filter is hard-coated for *no burn-out* performance.  
Five-year warranty.

## Triple-edge General Purpose Dichroic Beamsplitters (polarization-insensitive; for use at 45°)

For laser-optimized fluorescence dichroic beamsplitters, see page 51.

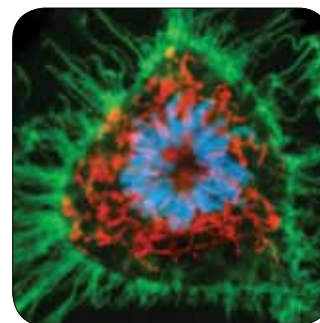
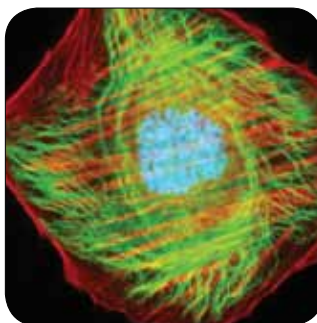
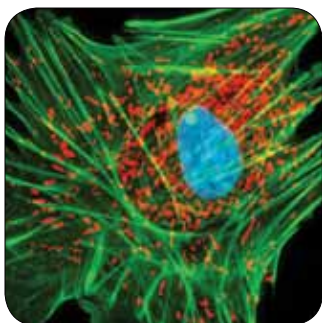
Nominal Edge Wavelength	Reflection Bands [1]	Transmission Bands [1]	Size (L x W x H)	Filter Part Number
395 nm 495 nm 610 nm	354 – 385 nm 465 – 483 nm 570 – 596 nm	403 – 446 nm 502 – 552 nm 620 – 750 nm	25.2 mm x 35.6 mm x 1.1 mm	FF395/495/610-Di01-25x36
403 nm 497 nm 574 nm	386 – 393 nm 466 – 490 nm 546 – 565 nm	414 – 450 nm 505 – 528 nm 584 – 645 nm	25.2 mm x 35.6 mm x 1.1 mm	FF403/497/574-Di01-25x36 <b>New!</b>
436 nm 514 nm 604 nm	394 – 414 nm 484 – 504 nm 566 – 586 nm	446 – 468 nm 520 – 540 nm 614 – 642 nm	25.2 mm x 35.6 mm x 1.1 mm	FF436/514/604-Di01-25x36
444 nm 520 nm 590 nm	327 – 437 nm 494 – 512 nm 562 – 578 nm	450 – 480 nm 527 – 547 nm 598 – 648 nm	25.2 mm x 35.6 mm x 1.1 mm	FF444/520/590-Di01-25x36
444 nm 521 nm 608 nm	420 – 430 nm 496 – 510 nm 579 – 596 nm	451 – 480 nm 530 – 561 nm 618 – 664 nm	25.2 mm x 35.6 mm x 1.1 mm	FF444/521/608-Di01-25x36
462 nm 522 nm 607 nm	430 – 453 nm 507 – 512 nm 580 – 595 nm	471 – 489 nm 532 – 560 nm 619 – 750 nm	25.2 mm x 35.6 mm x 1.1 mm	FF462/522/607-Di01-25x36
494 nm 540 nm 650 nm	488 nm (s polarization only) 532 nm 633 – 642 nm	500 – 519 nm 545 – 610 nm 655 – 700 nm	25.2 mm x 35.6 mm x 3.5 mm (NBK7 substrate)	FF494/540/650-Di01-25x36x3.5

[1] Wavelength ranges over which average reflection and transmission are guaranteed to be above 95% and 90%, respectively.

## Quadruple-edge Dichroic Beamsplitters (polarization-insensitive; for use at 45°)

Nominal Edge Wavelength	Reflection Bands [1]	Transmission Bands [1]	Size (L x W x H)	Filter Part Number
410 nm 504 nm 582 nm 669 nm	381 – 392 nm 475 – 495 nm 547 – 572 nm 643 – 656 nm	420 – 460 nm 510 – 531 nm 589 – 623 nm 677 – 722 nm	25.2 mm x 35.6 mm x 1.1 mm	FF410/504/582/669-Di01-25x36
416 nm 500 nm 582 nm 657 nm	400 – 410 nm 486 – 491 nm 560 – 570 nm 633 – 647 nm	422 – 473 nm 506 – 545 nm 586 – 617 nm 666 – 750 nm	25.2 mm x 35.6 mm x 1.5 mm	FF416/500/582/657-Di01-25x36x1.5

[1] Wavelength ranges over which average reflection and transmission are guaranteed to be above 95% and 90%, respectively.

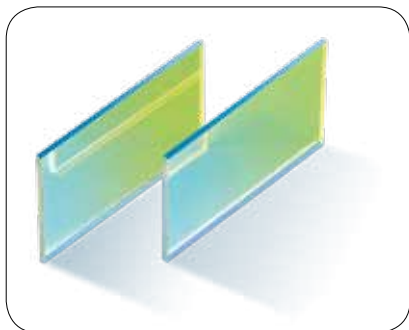


Images courtesy of Mike Davidson at Molecular Expressions™, using BrightLine® fluorescence filter sets.

# BrightLine® Multiedge Laser Dichroic Beamsplitters

Extensive selection.

Custom-sized filters are available in one week.



**New!**

The newest addition to our dichroic line up. Available in two or four edge wavelengths. Optimized for the most popular lasers used for fluorescence imaging, including the new all-solid-state lasers that are replacing older gas-laser technology. Laser Multiedge Dichroic Beamsplitters offer exceptionally high reflection at the laser wavelengths combined with very steep transitions from high reflection to high transmission (< 2.5% of the longest laser wavelength). They also offer sufficient flatness for laser applications (see *Technical Note* on page 47).

## Laser Multiedge Dichroic Beamsplitters

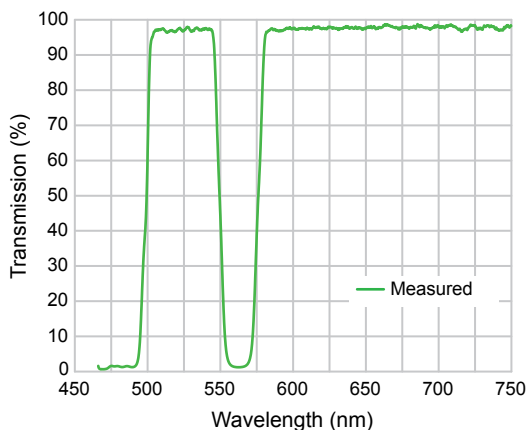
For Laser Dichroic Beamsplitter Common Specifications, see page 48.

**These items ship same day!**

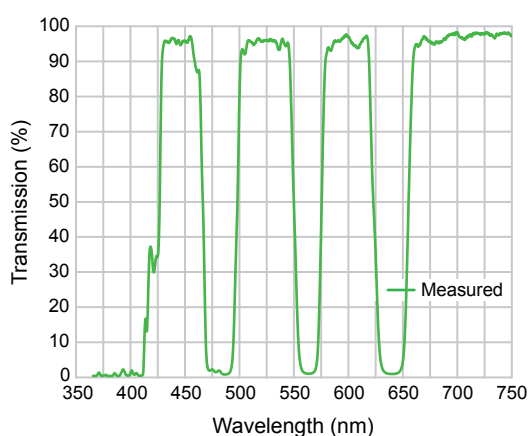
Nominal Edge Wavelength	Laser Wavelengths	Reflection Band	Avg. Transmission Band	Size (L x W x H)	Filter Part Number
499 nm 575 nm	473 ± 2 nm 488 +3/-2 nm	471 – 491 nm	503.3 – 543 nm	25.2 mm x 35.6 mm x 1.1 mm	Di01-R488/561-25x36 <b>New!</b>
	559 +5/-0 nm 561.4 nm 568.2 nm	559 – 568.2 nm	582.4 nm – 800 nm		
426 nm 498 nm 575 nm 655 nm	375 ±3 nm 405 ±5 nm	370 – 410 nm	429.5 – 462 nm	25.2 mm x 35.6 mm x 1.1 mm	Di01-R405/488/561/635/25x36 <b>New!</b>
	473 +2/-0 nm 488 +3/-2 nm	473 – 491 nm	502.5 – 544.5 nm		
	559 +5/-0 nm 561.4 nm 568.2 nm	559 – 568.2 nm	582 – 617.5 nm		
	623.8 nm 635 +7/-0 nm 647.1 nm	632.8 – 647.1 nm	663 – 800 nm		

For graphs & ASCII data, go to [www.semrock.com](http://www.semrock.com)

**Actual Measured Data**  
Di01-R488/561-25x36



**Actual Measured Data**  
Di01-R405/488/561/631-25x36



# Filters for Yokogawa CSU Confocal Scanners

Every Semrock filter is hard-coated for *no burn-out* performance. Five-year warranty.



Semrock offers fluorescence filters that enable you to achieve superior performance from your real-time confocal microscope system based on the Yokogawa CSU scanner. Like all BrightLine filters, they are made exclusively with hard, ion-beam-sputtered coatings to provide unsurpassed brightness and durability. These filters are compatible with all scan head system configurations, regardless of the microscope, camera, and software platforms you have chosen.

## Dichroic Beamsplitters for the Yokogawa CSU confocal scanners

These beamsplitters transmit the excitation laser light and reflect the fluorescence from the sample. Because the filters are precisely positioned between the spinning microlens array and pinhole array discs, they have been manufactured to exacting physical and spectral tolerances. The filter dimensions are 13.0 mm x 15.0 mm x 0.5 mm. (Installation in the CSU22 may be performed only by certain Yokogawa-authorized personnel.)

Transmitted Laser Wavelengths	Reflection Bands	Semrock Part Number
400-410 nm, 486-491 nm, 531-533 nm, 633-647 nm	422-473 nm, 503.5-517 nm, 548-610 nm, 666-750 nm	Di01-T405/488/532/647-13x15x0.5
405 nm, 488 nm, 561-568 nm, 638-647 nm	422-473 nm, 503-545 nm, 586-620 nm, 665-750 nm	Di01-T405/488/568/647-13x15x0.5
400-410 nm, 488 nm, 561 nm	422-473 nm, 503-544 nm, 578-750 nm	Di01-T405/488/561-13x15x0.5
405-442 nm, 514 nm, 638-647 nm	458-497 nm, 533-620 nm, 665-750 nm	Di01-T442/514/647-13x15x0.5
400-457 nm, 513-515 nm, 633-647 nm	471-498 nm, 535-616 nm, 666-750 nm	Di01-T457/514/647-13x15x0.5
405-442 nm, 502-508 nm, 630-641 nm	458-484 nm, 527-607 nm, 664-750 nm	Di01-T442/505/635-13x15x0.5
488 nm, 532 nm	442-473 nm, 503-510 nm, 554-750 nm	Di01-T488/532-13x15x0.5
488 nm, 568 nm	422-473 nm, 503-545 nm, 586-750 nm	Di01-T488/568-13x15x0.5
405-488 nm	508-700 nm	Di01-T488-13x15x0.5

## Emission Filters for the Yokogawa CSU confocal scanners

These filters mount outside the CSU head, typically in a filter wheel, and provide the utmost in transmission of the desired fluorescence while blocking the undesired scattered laser light and autofluorescence. The filters are 25.0 mm in diameter and are housed in black-anodized aluminum rings.

Blocked Laser Wavelengths	Transmission Bands	Semrock Part Number
405 nm, 488 nm, 561-568 nm	418-472 nm, 583-650 nm	Em01-R405/568-25
405 nm, 442 nm, 561-568 nm, 638-647 nm	458-512 nm, 663-750 nm	Em01-R442/647-25
405 nm, 488 nm	503-552 nm	Em01-R488-25
514 nm	528-650 nm	Em01-R514-25

## Laser-blocking Emission Filters for the Yokogawa CSU22 and CSU-X1 confocal scanner

(inside the scan head)

These filters go inside the CSU22 and CSU-X1 heads in the motorized emission-filter slider. The purpose is primarily to block undesired laser light, preventing it from exiting the scan head to the camera. The filters are 15.0 mm in diameter and are housed in black anodized aluminum rings. (Installation in the CSU22 may be performed only by certain Yokogawa-authorized personnel.)

Blocked Laser Wavelengths	Transmission Bands	Semrock Part Number
405 nm, 442 nm, 514 nm, 638 – 647 nm	458 – 497 nm, 529 – 620 nm, 667 – 750 nm	Em01-R442/514/647-15
405 nm, 442 nm, 488 nm, 561 – 568 nm	503 – 546 nm, 583 – 700 nm	Em01-R488/568-15

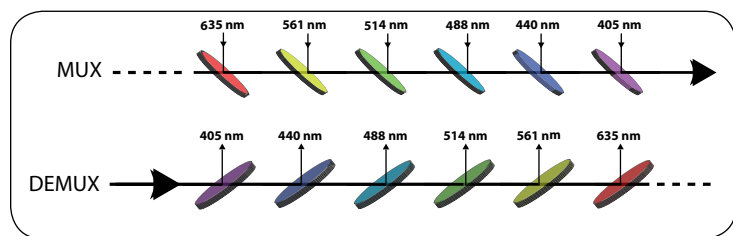
For graphs & ASCII data, go to [www.semrock.com](http://www.semrock.com)

# LaserMUX™ Beam Combining Filters

Extensive selection.

Custom-sized filters are available in one week.

LaserMUX filters are designed to efficiently combine or separate multiple laser beams at a 45° angle of incidence. These dichroic laser beam combiners are optimized to multiplex (MUX) popular laser lines, and can also be used in reverse to demultiplex (DEMUX). The ultra-low autofluorescence filters are ideally suited for OEM multi-laser fluorescence imaging and measurement applications including laser microscopy and flow cytometry, as well as for myriad end-user applications in a laboratory environment.



With high reflection and transmission performance at popular laser lines, these filters allow combining multiple different laser beams with exceptionally low loss. LaserMUX filters are hard-coated and come in an industry-standard 25 mm diameter x 3.5 mm thick black-anodized aluminum ring with a generous 22 mm clear aperture. Custom-sized filters are available in one week. Semrock also stocks a wide variety of other single-edge dichroic beamsplitters and multiedge dichroic beamsplitters.

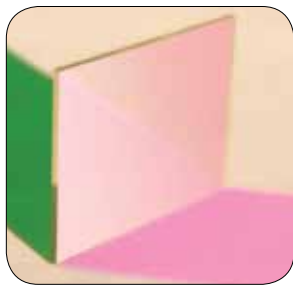
Reflected Laser Wavelengths	Reflection Band	Transmission Laser Wavelengths	Passband	Size (Diameter x Thickness)	Filter Part Number
375 ± 3 nm 405 +10/-5 nm	372.0 nm – 415.0 nm	440 +3/-1, 457.9, 473 +5/-0, 488 +3/-2, 514.5, 515, 532, 543.5, 561.4, 568.2, 594.1, 632.8, 635 +7/-0, 647.1 nm	439.0 nm – 647.1 nm	25 mm x 3.5 mm	LM01-427-25
440 +3/-1 nm 457.9 nm	439.0 nm – 457.9 nm	473 +5/-0, 488 +3/-2, 514.5, 515, 532, 543.5, 561.4, 568.2, 594.1, 632.8, 635 +7/-0, 647.1 nm	473.0 nm – 647.1 nm	25 mm x 3.5 mm	LM01-466-25
457.9 nm 473 nm	457.9 nm – 473.0 nm	488 +3/-0, 514.5, 515, 532, 543.5, 561.4, 568.2, 594.1, 632.8, 635 +7/-0, 647.1 nm	488.0 nm – 647.1 nm	25 mm x 3.5 mm	LM01-480-25 <b>New!</b>
473 +5/-0 nm 488 +3/-2 nm 1064.2 nm	473.0 nm – 491.0 nm	514.5, 515, 532, 543.5, 561.4, 568.2, 594.1, 632.8, 635 +7/-0, 647.1 nm	514.5 nm – 647.1 nm	25 mm x 3.5 mm	LM01-503-25
514.5 nm 515 nm 532 nm 543.5 nm	514.5 nm – 543.5 nm	561.4, 568.2, 594.1, 632.8, 635 +7/-0, 647.1, 671, 676.4, 785 ± 5 nm	561.4 nm – 790.0 nm	25 mm x 3.5 mm	LM01-552-25
561.4 nm 568.2 nm 594.1 nm	561.4 nm – 594.1 nm	632.8, 635 +7/-0, 647.1, 671, 676.4, 785 ± 5 nm	632.8 nm – 790.0 nm	25 mm x 3.5 mm	LM01-613-25
632.8 nm 635 +7/-0 nm 647.1 nm	632.8 nm – 647.1 nm	671, 676.4, 785 ± 5 nm	671.0 nm – 790.0 nm	25 mm x 3.5 mm	LM01-659-25

## LaserMUX Common Specifications

Property	Value	Comment
Absolute Reflection	> 99% (s-polarization) > 96% (p-polarization) > 98% (average polarization)	For reflected laser wavelengths
Average Reflection	> 98% (average polarization)	For reflection band
Absolute Transmission	> 94% (s-polarization) > 95% (p-polarization) > 95% (average polarization)	For transmitted laser wavelengths
Average Transmission	> 95% (average polarization)	For nominal passband
Angle of Incidence	45.0°	Based on a collimated beam of light
Performance for Non-collimated Light	The high-transmission portion of the long-wavelength edge and the low-transmission portion of the short-wavelength edge exhibit a small “blue shift” (shift toward shorter wavelengths). Even for cone half angles as large as 15° at normal incidence, the blue shift is only several nm.	
Clear Aperture	≥ 22 mm	For all optical specifications
Overall Mounted Diameter	25.0 mm + 0.0 / - 0.1 mm	Black anodized aluminium ring
Overall Mounted Thickness	3.5 mm + 0.0 / - 0.1 mm	Black anodized aluminium ring
Unmounted Thickness	2.0 mm +/- 0.1mm	
Beam Deviation	< 30 arc seconds	Based on 20 arc second substrate wedge angle

# Polarization Filters **New!**

Every Semrock filter is hard-coated for durable performance. Five-year warranty.



Semrock's latest innovation in optical filters combines a highly efficient polarizer and a bandpass filter in a single optical component! These unique, patent-pending filters are superb linear polarizers with a contrast ratio exceeding 1,000,000-to-1. In addition, with high-performance bandpass characteristics (including high transmission and steep edges), they make an excellent laser source clean-up filter (eliminating undesired polarization and light noise away from the laser wavelength) as well as detection filters to pass a laser wavelength range and block background noise.

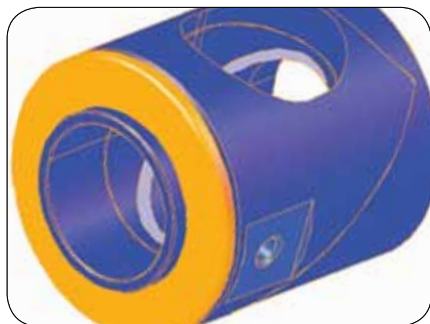
Semrock's new polarizing bandpass filters are ideal for a wide variety of laboratory laser applications, especially those involving holographic and interferometric systems, as well as fluorescence polarization assays and imaging, second-harmonic-generation imaging, polarization diversity detection in communications and rangefinding, laser materials processing, and laser intensity control.

- ▶ Contrast ratio > 1,000,000:1
- ▶ High transmission (> 95%) within optimized passband (for p-polarization light)
- ▶ Superior optical quality – low scatter, wavefront distortion, and beam deviation
- ▶ Hard-coating reliability and high laser damage threshold (1 J/cm<sup>2</sup>)
- ▶ Naturally offers large aperture sizes and 90° beamsplitter functionality

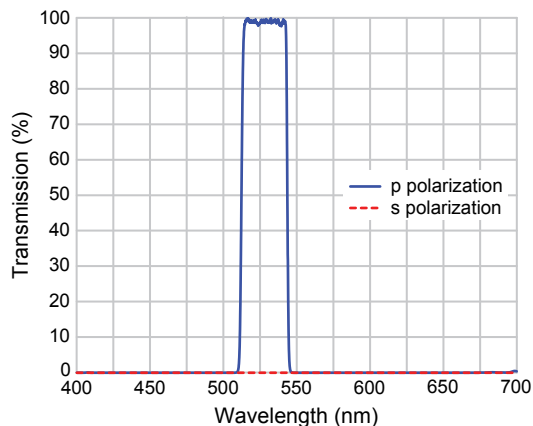
**These items ship same day!**

Nominal Laser Wavelength	Wavelength Range for AOI = 45° ± 0.5°	AOI Range for Nominal Laser Wavelength	OD 2 Avg. Polarization Blocking Range	OD 6 S-Pol Blocking Range	OD 6 P-Pol Blocking Range	Part Number	
405 nm	400 – 410 nm	41° – 51°	300 – 332 nm 490 – 1100 nm	320 – 516 nm	332 – 388 nm 422 – 490 nm	PBP01-405/10-25x36	<b>New!</b>
532 nm	518 – 541 nm	38° – 52°	300 – 418 nm 664 – 1100 nm	400 – 695 nm	418 – 502 nm 557 – 664 nm	PBP01-529/23-25x36	<b>New!</b>
640 nm	628.5 – 650 nm	40.5° – 51°	300 – 511 nm 795 – 1100 nm	488 – 840 nm	511 – 602 nm 675 – 795 nm	PBP01-639/21-25x36	<b>New!</b>

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)



See [www.semrock.com](http://www.semrock.com) or contact us about polarization filter mounting options.



These unique polarizing bandpass filters offer a superb linear polarizer and optimized bandpass filter in a single optical component.



# Polarization Filters

Extensive selection.  
Custom-sized filters are available in one week.

## Common Specifications

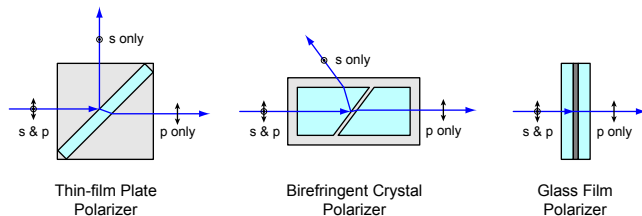
Property	Value	Comments
Guaranteed Transmission	> 95%	p-polarized light
Contrast	1,000,000:1	Ratio of transmission through two identical aligned polarizers to transmission through same pair of crossed polarizers
Blocking	See table on page 54	
Nominal Angle of Incidence	45°	AOI tolerance (See table on page 54)
Laser Damage Threshold	1 J/cm <sup>2</sup> @ 532 nm	10 ns pulse width P-pol (See page 76)
Substrate Material	Ultra-low autofluorescence fused silica	
Dimensions & Tolerance	25.2 mm x 35.6 mm x 2.0 mm ± 0.1 mm	See www.semrock.com for mount option
Clear Aperture	≥ 85%	Elliptical, for all optical specifications
Transmitted Wavefront Error	< λ/4 RMS at λ = 633 nm	Peak-to-valley error < 5 x RMS
Beam Deviation	≤ 10 arc seconds	Measured per inch
Surface Quality	40-20 scratch-dig	Measured within clear aperture
Orientation	Coating (Text) away from light	For use as a polarizer
	Coating (Text) towards light	For use as an analyzer

## TECHNICAL NOTE

### Thin-film Plate Polarizers

A “polarizer” transmits a single state of polarization of light while absorbing, reflecting, or deviating light with the orthogonal state of polarization. Applications include fluorescence polarization assays and imaging, second-harmonic-generation imaging, polarization diversity detection in communications and ranging, and laser materials processing, to name a few. Polarizers are characterized by the “contrast ratio,” or the ratio of the transmission through a pair of identical aligned polarizers to the transmission through the same pair of crossed polarizers. Contrast ratios typically vary from about 100:1 to as large as 100,000:1.

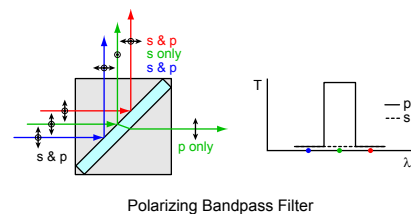
Three of the most common high-contrast polarizers are shown in the diagram on the right. Thin-film plate polarizers, like those made by Semrock, are based on interference within a dielectric optical thin-film coating on a thin glass substrate. In birefringent crystal polarizers different polarization orientations of light rays incident on an interface are deviated by different amounts. In “Glan” calcite polarizers, extinction is achieved by total internal reflection of s-polarized light at a crystal-air gap (Glan-laser) or crystal-epoxy gap (Glan-Thompson). Glass film polarizers selectively absorb one orientation of linearly polarized light more strongly than the other.



Thin-film plate polarizers have a number of unique advantages relative to other types of polarizers, including superior transmission and optical quality – low scattering, wavefront distortion, and beam deviation that can cause beam walk during rotation. They can be made with excellent environmental reliability, the highest laser damage thresholds, and large aperture sizes (inches). And they naturally function as beamsplitters with a 90° beam deviation of the blocked polarization. Unlike birefringent crystal polarizers, thin-film plate polarizers tend to function over only a range of wavelengths since they are based on multiwave interference, and thus they are best suited for laser applications or for systems with limited signal band.

Birefringent crystal polarizers tend to have very limited aperture size due to the high cost of growing good optical-quality crystals, and they are not well suited for imaging applications. Besides a somewhat limited wavelength range, the main limitations of glass film polarizers are low transmission of the desired light and low optical damage threshold, making them unsuitable for many laser applications.

Semrock’s ion beam sputtering technology has enabled breakthrough improvements in performance of traditional thin-film plate polarizers. Foremost among these is contrast – Semrock polarizers are guaranteed to achieve higher than 1,000,000:1 contrast, rivaled only by the lower-transmission and low optical damage-threshold glass film polarizers. And, only Semrock polarizers can achieve unique spectral performance like our patent-pending “polarizing bandpass filters” (see figure on the right).



# Laser Wavelength Reference Table

Laser Line	Laser Type	Prominent Applications	Polarization Filters	RazorEdge (LWP)	MaxLine	MaxDiode	StopLine	EdgeBasic	BrightLine Laser Dichroics	LaserMUX	MaxMirror
			Pg 54	Pg 59	Pg 65	Pg 68	Pg 71	Pg 57	Pg 48	Pg 53	Pg 75
224.3	HeAg gas	Raman		●							
248.6	NeCu gas	Raman		●	●						
257.3	Doubled Ar-ion gas	Raman		●							
266.0	Quadrupled DPSS	Raman		●	●						
325.0	HeCd gas	Raman		●	●						
355.0	Tripled DPSS	Raman		●	●						●
363.8	Ar-ion gas	Raman		●	●						●
~ 375	Diode	Fluorescence (DAPI)				●			●	●	●
~ 405	Diode	Fluorescence (DAPI)	●			●	●		●	●	●
~ 440	Diode	Fluorescence (CFP)				●			●	●	●
441.6	HeCd gas	Raman, Fluorescence (CFP)		●	●		●		●	●	●
457.9	Ar-ion gas	Fluorescence (CFP)		●	●				●	●	●
~ 470	Diode	Fluorescence (GFP)				●			●	●	●
473.0	Doubled DPSS	Fluorescence (GFP), Raman		●		●			●	●	●
488.0	Ar-ion gas	Raman, Fluorescence (FITC, GFP)		●	●		●	●	●	●	●
~ 488	Doubled OPS	Fluorescence (FITC, GFP)					●	●	●	●	●
491.0	Doubled DPSS	Fluorescence (FITC, GFP)					●	●	●	●	●
514.5	Ar-ion gas	Raman, Fluorescence (YFP)		●	●		●		●	●	●
515.0	Doubled DPSS	Fluorescence (YFP)		●			●		●	●	●
532.0	Doubled DPSS	Raman, Fluorescence	●	●	●		●	●	●	●	●
543.5	HeNe gas	Fluorescence (TRITC, Cy3)								●	●
561.4	Doubled DPSS	Fluorescence (RFP, Texas Red)		●	●		●		●	●	●
568.2	Kr-ion gas	Fluorescence (RFP, Texas Red)		●	●		●		●	●	●
593.5	Doubled DPSS	Fluorescence (RFP, Texas Red)					●			●	●
594.1	HeNe gas	Fluorescence (RFP, Texas Red)					●			●	●
632.8	HeNe gas	Raman, Fluorescence (Cy5)	●	●	●		●	●	●	●	●
~ 635	Diode	Fluorescence (Cy5)	●			●	●	●	●	●	●
647.1	Kr-ion gas	Fluorescence (Cy5)	●	●	●				●	●	●
664.0	Doubled DPSS	Raman		●							●
671.0	Doubled DPSS	Raman, Fluorescence (Cy5.5, Cy7)			●						●
780.0	EC diode	Raman		●	●			●			●
~ 785	Diode	Raman				●	●	●			●
785.0	EC Diode	Raman		●	●	●	●	●			●
~ 808	Diode	DPSS pumping, Raman		●	●		●				●
830.0	EC diode	Raman		●	●		●				●
976.0	EC diode	Raman		●	●						●
980.0	EC diode	Raman		●	●						●
1047.1	DPSS	Raman			●						●
1064.0	DPSS	Raman		●	●						●
1319.0	DPSS	Raman		●							●

Key: Diode = semiconductor diode laser      EC diode = wavelength-stabilized external-cavity diode laser  
 DPSS = diode-pumped solid-state laser      OPS = optically pumped semiconductor laser  
 Doubled, Tripled, Quadrupled = harmonic frequency upconversion using nonlinear optics

# EdgeBasic™ Long Wave Pass Filters

Extensive selection.  
Custom-sized filters are available in one week.

EdgeBasic long-wave-pass filters offer a superb combination of performance and value for applications in Raman spectroscopy and fluorescence imaging and measurements. This group of filters is ideal for specific Raman applications that do not require measuring the smallest possible Raman shifts, yet demand exceptional laser-line blocking and high transmission over a range of Raman lines.

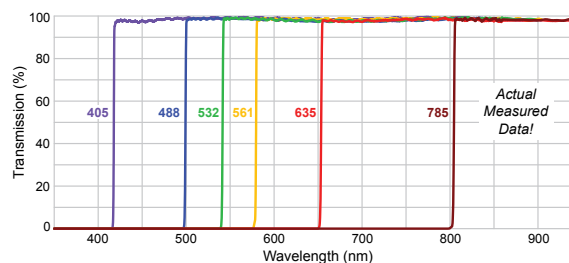


- ▶ Deep laser-line blocking – for maximum laser rejection (OD > 6)
- ▶ Extended short-wavelength blocking – for high-fidelity fluorescence imaging
- ▶ High signal transmission – to detect the weakest signals (> 98% typical)
- ▶ Proven **no burn-out** durability – for lasting and reliable performance
- ▶ For the ultimate performance, upgrade to state-of-the-art RazorEdge® Raman filters (see page 59)

**These items ship same day!**

Nominal Laser Wavelength	Laser Wavelength Range		Passband	Part Number
	$\lambda_{\text{short}}$	$\lambda_{\text{long}}$		
405 nm	400.0 nm	410.0 nm	421.5 – 900.0 nm	BLP01-405R-25
488 nm	486.0 nm	491.0 nm	504.7 – 900.0 nm	BLP01-488R-25
532 nm	532.0 nm	532.0 nm	546.9 – 900.0 nm	BLP01-532R-25
561 nm	561.0 nm	568.0 nm	583.9 – 900.0 nm	BLP01-561R-25
635 nm	632.8 nm	642.0 nm	660.0 – 1200.0 nm	BLP01-635R-25
785 nm	780.0 nm	790.0 nm	812.1 – 1200.0 nm	BLP01-785R-25

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)



## Common Specifications

Property	Value	Comments
Edge Steepness (typical)	1.5% of $\lambda_{\text{long}}$	Measured from OD 6 to 50%
Blocking at Laser Wavelengths	OD > 6 from $\lambda_{\text{short}}$ to $\lambda_{\text{long}}$ OD > 5 from 270 nm to 80% of $\lambda_{\text{short}}$	OD = $-\log_{10}$ (transmission)
Transition Width	< 2.5% of $\lambda_{\text{long}}$	From $\lambda_{\text{long}}$ to the 50% transmission wavelength
Guaranteed Transmission	> 93%	Averaged over the passband
Typical Transmission	> 98%	Averaged over the passband
Minimum Transmission	> 90%	Over the passband
Angle of Incidence	$0.0^\circ \pm 2.0^\circ$	Range for above optical specifications
Cone Half Angle	< $5^\circ$	Rays uniformly distributed about $0^\circ$
Angle Tuning Range	– 0.3% of Laser Wavelength	Wavelength “blue shift” increasing angle from $0^\circ$ to $8^\circ$
Substrate Material	Low-autofluorescence optical quality glass	
Clear Aperture	> 22 mm	
Outer Diameter	$25.0 + 0.0 / - 0.1$ mm	Black-anodized aluminum ring
Overall Thickness	$3.5 \pm 0.1$ mm	Black-anodized aluminum ring
Beam Deviation	< 10 arc seconds	
Surface Quality	60-40 scratch-dig	
Filter Orientation	Arrow on ring indicates preferred direction of propagation of light	

# PRODUCT NOTE

## Edge Steepness and Transition Width

Semrock edge filters – including our steepest RazorEdge® Raman filters as well as our EdgeBasic™ filters for application-specific Raman systems and fluorescence imaging – are specified with a guaranteed “Transition Width.”

Transition Width = maximum allowed spectral width between the laser line (where OD > 6) and the 50% transmission point

Any given filter can also be described by its “Edge Steepness,” which is the actual steepness of the filter, regardless of the precise wavelength placement of the edge.

Edge Steepness = actual steepness of a filter measured from the OD 6 point to the 50% transmission point

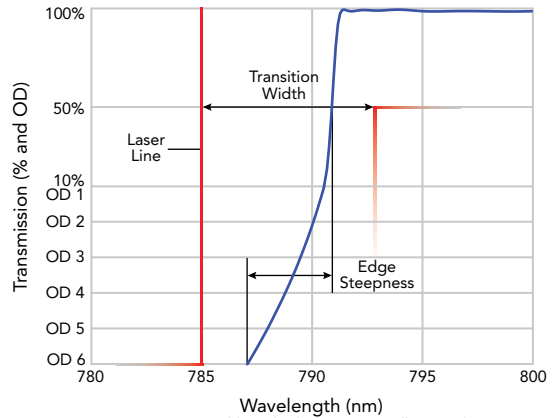


Figure 1: Transition width and edge steepness illustrated.

Figure 1 illustrates Transition Width and Edge Steepness for an edge filter designed to block the 785 nm laser line (example shows a “U-grade” RazorEdge filter). Table 1 below lists the guaranteed Transition Width, typical Edge Steepness, and price (for 25 mm diameter parts) for Semrock edge filters.

Edge Filter Type	Guaranteed Transition Width (% of laser wavelength)	Typical Edge Steepness (% of laser wavelength)
RazorEdge “E-grade”	< 0.5% (< 90 cm <sup>-1</sup> for 532)	0.2% (1.1 nm for 532)
RazorEdge “U-grade”	< 1.0% (< 186 cm <sup>-1</sup> for 532)	0.5% (2.7 nm for 532)
RazorEdge “S-grade”	< 2.0% (< 369 cm <sup>-1</sup> for 532)	0.5% (2.7 nm for 532)
EdgeBasic	< 2.5% (< 458 cm <sup>-1</sup> for 532)	1.5% (8 nm for 532)

\* except UV filters

All RazorEdge filters provide exceptional steepness to allow measurement of signals very close to the blocked laser line with high signal-to-noise ratio. However, the state-of-the-art “E-grade” RazorEdge filters take closeness to an Extreme level.

The graph at the right illustrates that “U-grade” RazorEdge filters have a transition width that is 1% of the laser wavelength – thus a 785 nm filter is guaranteed to have > 50% transmission by 792.9 nm, corresponding to a maximum wavenumber shift of 126 cm<sup>-1</sup>. “E-grade” filters have a Transition Width that is twice as narrow, or 0.5% of the laser line! So a 785 nm filter is guaranteed to have > 50% transmission by 788.9 nm, corresponding to a maximum wavenumber shift of 63 cm<sup>-1</sup>.

“Edge steepness” is the actual steepness of the filter, regardless of the precise wavelength placement of the edge. “U-grade” RazorEdge filters are designed to have a steepness of 0.5% of the laser wavelength, or 3.9 nm (63 cm<sup>-1</sup>) for a 785 nm filter. The “E-grade” filters are designed to have an edge steepness that 2.5x narrower – only 0.2% of the laser wavelength, or 1.6 nm (25 cm<sup>-1</sup>) for a 785 nm filter.

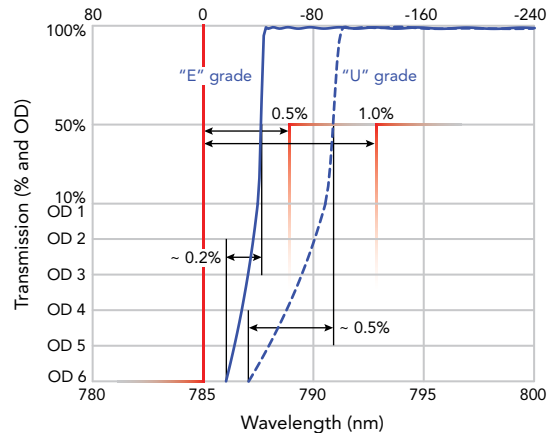


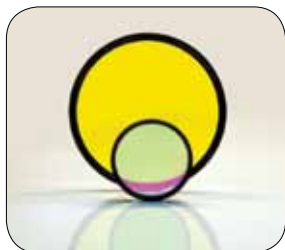
Figure 2: Transition widths and edge steepnesses for LP02-785RE and LP02-785RU filters (see page 59).

# RazorEdge® Long Wave Pass Raman Edge Filters

Extensive selection.

Custom-sized filters are available in one week.

Semrock stocks an unsurpassed selection of the highest performance edge filters available for Raman Spectroscopy, with edge wavelengths from 224 to 1319 nm. Now you can see the weakest signals closer to the laser line than you ever have before. With their deep laser-line blocking, ultra-wide and low-ripple passbands, proven hard-coating reliability, and high laser damage threshold, they offer performance that lasts. U.S. Patent No. 7,068,430 and pending.



- ▶ **The steepest edge filters on the market – RazorEdge E-grade filters**  
(See just how steep on page 58)
- ▶ For long-wave-pass edge filters for normal incidence, see below
- ▶ For short-wave-pass edge filters for normal incidence, see page 61
- ▶ For ultrasteep 45° beamsplitters, see page 62
- ▶ For a suitably matched MaxLine® filter, see page 65

## 25 mm Diameter

**These items ship same day!**

Laser Line	Transition Width [1]	Passband	Part Number
224.3 nm	< 1920 cm <sup>-1</sup>	235.0-505.9 nm	LP02-224R-25
248.6 nm	< 805 cm <sup>-1</sup>	261.0-560.8 nm	LP02-248RS-25
257.3 nm	< 385 cm <sup>-1</sup> < 762 cm <sup>-1</sup>	263.0-580.4 nm 265.5-580.4 nm	LP02-257RU-25 LP02-257RS-25
266.0 nm	< 372 cm <sup>-1</sup> < 737 cm <sup>-1</sup>	272.4-600.0 nm 275.0-600.0 nm	LP02-266RU-25 LP02-266RS-25
325.0 nm	< 305 cm <sup>-1</sup> < 603 cm <sup>-1</sup>	329.2-733.1 nm 332.5-432.5 nm	LP03-325RU-25 LP02-325RS-25
355.0 nm	< 279 cm <sup>-1</sup> < 552 cm <sup>-1</sup>	359.6-800.8 nm 363.2-800.8 nm	LP02-355RU-25 LP02-355RS-25
363.8 nm	< 272 cm <sup>-1</sup> < 539 cm <sup>-1</sup>	368.5-820.6 nm 372.2-820.6 nm	LP02-364RU-25 LP02-364RS-25
441.6 nm	< 224 cm <sup>-1</sup> < 444 cm <sup>-1</sup>	447.3-996.1 nm 451.8-996.1 nm	LP02-442RU-25 LP02-442RS-25
457.9 nm	< 216 cm <sup>-1</sup> < 428 cm <sup>-1</sup>	463.9-668.4 nm 468.4-668.4 nm	LP02-458RU-25 LP02-458RS-25
473.0 nm	< 209 cm <sup>-1</sup> < 415 cm <sup>-1</sup>	479.1-1066.9 nm 483.9-1066.9 nm	LP02-473RU-25 LP02-473RS-25
488.0 nm	< 102 cm <sup>-1</sup> < 203 cm <sup>-1</sup> < 402 cm <sup>-1</sup>	491.2-1100.8 nm 494.3-1100.8 nm 499.2-1100.8 nm	LP02-488RE-25 LP02-488RU-25 LP02-488RS-25
514.5 nm	< 97 cm <sup>-1</sup> < 192 cm <sup>-1</sup> < 381 cm <sup>-1</sup>	517.8-1160.5 nm 521.2-1160.5 nm 526.3-1160.5 nm	LP02-514RE-25 LP02-514RU-25 LP02-514RS-25
532.0 nm	< 90 cm <sup>-1</sup> < 186 cm <sup>-1</sup> < 369 cm <sup>-1</sup>	535.4-1200.0 nm 538.9-1200.0 nm 544.2-1200.0 nm	LP03-532RE-25 LP03-532RU-25 LP03-532RS-25
561.4 nm	< 176 cm <sup>-1</sup> < 349 cm <sup>-1</sup>	568.7-1266.3 nm 574.0-1266.3 nm	LP02-561RU-25 LP02-561RS-25
568.2 nm	< 174 cm <sup>-1</sup> < 345 cm <sup>-1</sup>	575.6-1281.7 nm 581.3-1281.7 nm	LP02-568RU-25 LP02-568RS-25
632.8 nm	< 79 cm <sup>-1</sup> < 156 cm <sup>-1</sup> < 310 cm <sup>-1</sup>	636.9-1427.4 nm 641.0-1427.4 nm 647.4-1427.4 nm	LP02-633RE-25 LP02-633RU-25 LP02-633RS-25

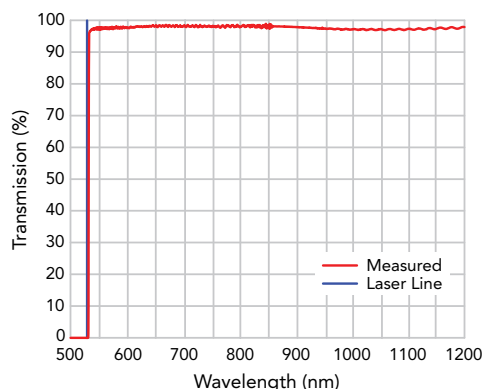
**New!**

Laser Line	Transition Width [1]	Passband	Part Number
664.0 nm	< 149 cm <sup>-1</sup> < 295 cm <sup>-1</sup>	672.6-1497.7 nm 679.3-1497.7 nm	LP02-664RU-25 LP02-664RS-25
780.0 nm	< 127 cm <sup>-1</sup> < 251 cm <sup>-1</sup>	790.1-1008.0 nm 797.9-1008.0 nm	LP01-780RU-25 LP01-780RS-25
785.0 nm	< 63 cm <sup>-1</sup> < 126 cm <sup>-1</sup> < 250 cm <sup>-1</sup>	790.1-1770.7 nm 795.2-1770.7 nm 803.1-1770.7 nm	LP02-785RE-25 LP02-785RU-25 LP02-785RS-25
808.0 nm	< 123 cm <sup>-1</sup> < 243 cm <sup>-1</sup>	818.5-1822.6 nm 826.6-1822.6 nm	LP02-808RU-25 LP02-808RS-25
830.0 nm	< 119 cm <sup>-1</sup> < 236 cm <sup>-1</sup>	840.8-1872.2 nm 849.1-1872.2 nm	LP02-830RU-25 LP02-830RS-25
980.0 nm	< 101 cm <sup>-1</sup> < 200 cm <sup>-1</sup>	992.7-2000.0 nm 1002.5-2000.0 nm	LP02-980RU-25 LP02-980RS-25
1064.0 nm	< 93 cm <sup>-1</sup> < 184 cm <sup>-1</sup>	1077.8-2000.0 nm 1088.5-2000.0 nm	LP02-1064RU-25 LP02-1064RS-25
1319.0 nm	< 75 cm <sup>-1</sup> < 149 cm <sup>-1</sup>	1336.1-2000.0 nm 1349.3-2000.0 nm	LP02-1319RU-25 LP02-1319RS-25

[1] See pages 58 and 69 for more on Transition Width and wavenumbers

See [www.semrock.com](http://www.semrock.com) for additional E-grade offerings.

Actual measured data (532 nm E-grade filter)



See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

# RazorEdge® Long Wave Pass Raman Edge Filters

Every Semrock filter is hard-coated for durable performance.  
Five-year warranty.

## 50 mm Diameter – Same Performance over 4x the Area

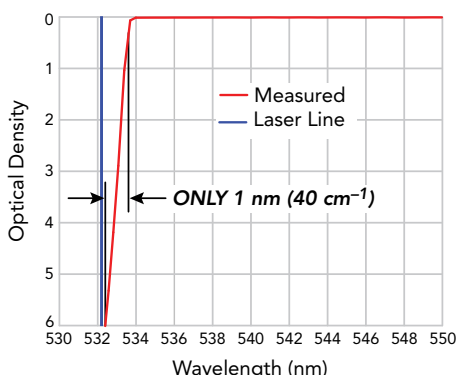
The “-25” in the part numbers on the previous page indicates these filters are 25 mm in diameter. All visible and near-IR U- and S-grade wavelengths are available in 50 mm diameters. See the table below for changes to the part numbers and prices.

Laser Line	Part Number
Long Wave Pass Edge Filters For wavelengths listed on page 59 <sup>[1]</sup>	LPO_-__RU-50
	LPO_-__RS-50

<sup>[1]</sup> U- and S-grade filters only, except 224.3, 248.6, 257.3, and 266 nm filters – call for availability.

### RazorEdge Raman Filter Spectra

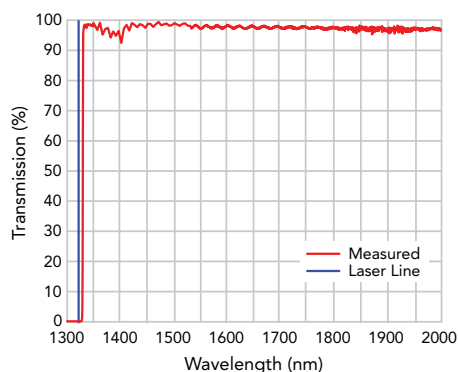
Actual measured OD for a 532 nm E-grade filter



### Expand deeper into the IR

(see page 69 for Near-IR bandpass filters)

Actual measured 1319 U-grade filter



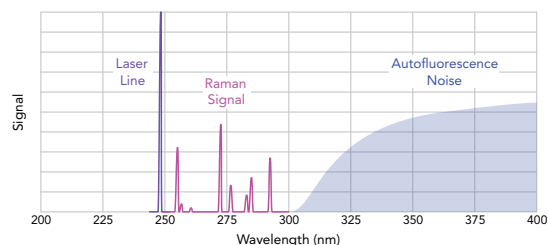
## TECHNICAL NOTE

### Ultraviolet (UV) Raman Spectroscopy

Raman spectroscopy measurements generally face two limitations: (1) Raman scattering cross sections are tiny, requiring intense lasers and sensitive detection systems just to achieve enough signal; and (2) the signal-to-noise ratio is further limited by fundamental, intrinsic noise sources like sample autofluorescence. Raman measurements are most commonly performed with green, red, or near-infrared (IR) lasers, largely because of the availability of established lasers and detectors at these wavelengths. However, by measuring Raman spectra in the ultraviolet (UV) wavelength range, both of the above limitations can be substantially alleviated.

Visible and near-IR lasers have photon energies below the first electronic transitions of most molecules. However, when the photon energy of the laser lies within the electronic spectrum of a molecule, as is the case for UV lasers and most molecules, the intensity of Raman-active vibrations can increase by many orders of magnitude – this effect is called “resonance-enhanced Raman scattering.”

Further, although UV lasers tend to excite strong autofluorescence, it typically occurs only at wavelengths above about 300 nm, independent of the UV laser wavelength. Since



even a 4000  $\text{cm}^{-1}$  (very large) Stokes shift leads to Raman emission below 300 nm when excited by a common 266 nm laser, autofluorescence simply does not interfere with the Raman signal making high signal-to-noise ratio measurements possible.

Recently an increasing number of compact, affordable, and high-power UV lasers have become widely available, such as quadrupled, diode-pumped Nd:YAG lasers at 266 nm and NeCu hollow-cathode metal-ion lasers at 248.6 nm, making ultra-sensitive UV Raman spectroscopy a now widely accessible technique.

# RazorEdge® Short Wave Pass Raman Edge Filters

Extensive selection.

Custom-sized filters are available in one week.

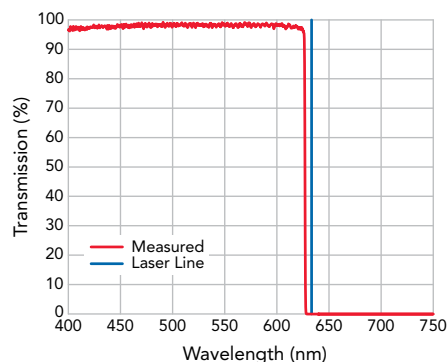
## 25 mm Diameter

These unique filters (U.S. patent No. 7,068,430) are ideal for Anti-Stokes Raman applications. An addition to the popular high-performance RazorEdge family of steep edge filters, these short-wave-pass filters are designed to attenuate a designated laser-line by six orders of magnitude, and yet maintain a typical edge steepness of only 0.5% of the laser wavelength. Both short- and long-wave-pass RazorEdge filters are perfectly matched to Semrock's popular MaxLine® laser-line cleanup filters.

**These items ship same day!**

Laser Line	Transition Width	Passband	Part Number
532.0 nm	< 186 cm <sup>-1</sup>	350.0 – 525.2 nm	SP01-532RU-25
561.4 nm	< 176 cm <sup>-1</sup>	400.0 – 554.1 nm	SP01-561RU-25 <b>New!</b>
632.8 nm	< 160 cm <sup>-1</sup>	372.0 – 624.6 nm	SP01-633RU-25
785.0 nm	< 129 cm <sup>-1</sup>	400.0 – 774.8 nm	SP01-785RU-25

Actual measured data from a 632.8 nm RazorEdge filter



## 50 mm Diameter – Same Performance over 4x the Area

All above wavelengths are also available in 50 mm diameter. See the table below for changes to the part numbers and prices.

Laser Line	Part Number
Short Wave Pass Edge Filters For wavelengths listed above	SP01-____RU-50

See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

## PRODUCT NOTE

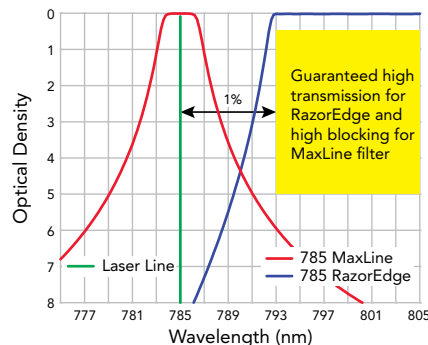
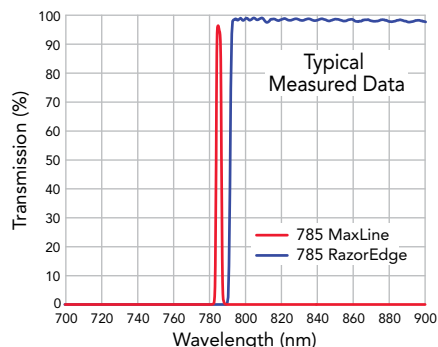
### RazorEdge and MaxLine® are a Perfect Match

The MaxLine (see page 65) and RazorEdge U- and S-grade (see page 59) filters make an ideal filter pair for applications like Raman spectroscopy – they fit together like hand-in-glove. The MaxLine filter spectrally “cleans up” the excitation laser light before it reaches the sample under test – allowing only the desired laser line to reach the sample – and then the RazorEdge filter removes the laser line from the light scattered off of the sample, while efficiently transmitting desired light at wavelengths very close to the laser line.

Typical measured spectral curves of 785 nm filters on a linear transmission plot demonstrate how the incredibly steep edges and high transmission exhibited by both of these filters allow them to be spectrally positioned very close together, while still maintaining complementary transmission and blocking characteristics.

The optical density plot (for explanation of OD, see page 74) illustrates the complementary nature of these filters on a logarithmic scale using the theoretical design spectral curves. The MaxLine filter provides very high transmission (> 90%) of light immediately in the vicinity of the laser line, and then rapidly rolls off to achieve very high blocking (> OD 5) at wavelengths within 1% of the laser line. The RazorEdge filter provides extremely high blocking (> OD 6) of the laser line itself, and then rapidly climbs to achieve very high transmission (> 90%) of the desired signal light at wavelengths only 1% away from the laser line.

If you are currently using an E-grade RazorEdge filter and need a MaxLine filter, please contact Semrock.



# RazorEdge Dichroic™ Beamsplitters

Every Semrock filter is hard-coated for durable performance.  
Five-year warranty.



Only the unique RazorEdge Dichroic beamsplitter reflects a standard laser line incident at 45° while transmitting longer Raman-shifted wavelengths with an ultrasteep transition far superior to anything else available on the open market. The guaranteed transition width of < 1% of the laser wavelength for U-grade (regardless of polarization) makes these filters a perfect match to our popular normal-incidence RazorEdge ultrasteep long-wave-pass filters (see page 59). These beamsplitters are so innovative that they are patent pending.

## 25 mm Diameter

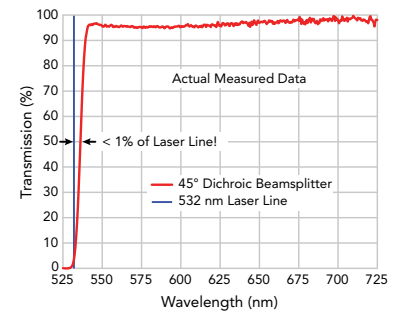
Mounted in 25 mm diameter x 3.5 mm thick black-anodized aluminum ring

**These items ship same day!**

Laser Line	Transition Width [1]	Passband	Part Number
488.0 nm	< 203 cm <sup>-1</sup> < 402 cm <sup>-1</sup>	494.3-756.4 nm 499.2-756.4 nm	LPD01-488RU-25 LPD01-488RS-25
514.5 nm	< 192 cm <sup>-1</sup> < 381 cm <sup>-1</sup>	521.2-797.5 nm 526.3-797.5 nm	LPD01-514RU-25 LPD01-514RS-25
532.0 nm	< 186 cm <sup>-1</sup> < 369 cm <sup>-1</sup>	538.9-824.8 nm 544.2-824.8 nm	LPD01-532RU-25 LPD01-532RS-25
632.8 nm	< 156 cm <sup>-1</sup> < 310 cm <sup>-1</sup>	641.0-980.8 nm 647.4-980.8 nm	LPD01-633RU-25 LPD01-633RS-25
785.0 nm	< 126 cm <sup>-1</sup> < 250 cm <sup>-1</sup>	795.2-1213.8 nm 803.1-1213.8 nm	LPD01-785RU-25 LPD01-785RS-25

[1] See page 69 for more on wavenumbers.

Actual data from a 532.0 nm RazorEdge Dichroic Beamsplitter



See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

## 25 mm x 36 mm x 2.0 mm Rectangular

**These items ship same day!**

Laser Line	Part Number
RazorEdge Dichroic Beamsplitters For wavelengths listed above	LPD01-__RU-25x36x2.0 LPD01-__RS-25x36x2.0

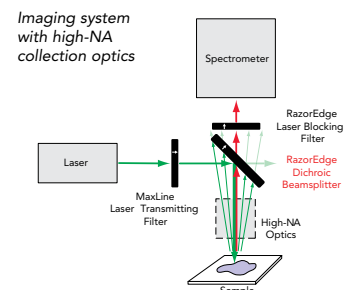
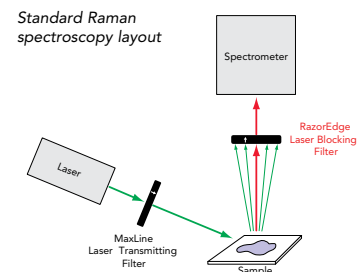
See [www.semrock.com](http://www.semrock.com) for availability of 1.1 mm thickness.

## TECHNICAL NOTE

### RazorEdge Filter Layouts

Only the unique RazorEdge Dichroic beamsplitter reflects a standard laser line incident at 45° while transmitting longer Raman-shifted wavelengths with an ultrasteep transition far superior to anything else available on the open market. The guaranteed transition width of < 1% of the laser wavelength for U-grade (regardless of polarization) makes these filters a perfect match to our popular normal-incidence RazorEdge ultrasteep long-wave-pass filters (see page 59). These beamsplitters are so innovative that they are patent pending.

In order for the two-filter configuration to work, the 45° beamsplitter must be as steep as the laser-blocking filter. Traditionally thin-film filters could not achieve very steep edges at 45° because of the “polarization splitting” problem – the edge position tends to be different for different polarizations of light. However, through continued innovation in thin-film filter technology, Semrock has been able to achieve ultrasteep 45° beamsplitters with the same steepness of our renowned RazorEdge laser-blocking filters: the transition from the laser line to the passband of the filter is guaranteed to be less than 1% of the laser wavelength (for U-grade filters).





## RazorEdge Specifications

Properties apply to all long-wave-pass and short-wave-pass edge filters unless otherwise noted

Property	Specification	Comment
Edge Steepness (typical)	"E-grade"	0.2% of laser wavelength
	"U- & S-grades"	0.5% of laser wavelength
Blocking at Laser Wavelength	> 6 OD	OD = $-\log_{10}$ (transmission)
Transition Width	"E-grade"	< 0.5% of laser wavelength
	"U-grade"	< 1% of laser wavelength
	"S-grade"	< 2% of laser wavelength
Guaranteed Passband Transmission	> 93%	Except > 90% for 224 - 325 nm filters; Averaged over the Passband ( <i>Passband wavelengths on page 59 for LWP and page 61 for SWP filters</i> )
Typical Passband Transmission	> 98%	
Angle of Incidence	0.0° ± 2.0°	Range for above optical specifications
Cone Half Angle	< 5°	Rays uniformly distributed about 0°
Angle Tuning Range <sup>(1)</sup>	- 0.3% of Laser Wavelength (-1.6 nm or + 60 cm <sup>-1</sup> for 532 nm filter)	Wavelength "blue shift" attained by increasing angle from 0° to 8°
Laser Damage Threshold	0.5 J/cm <sup>2</sup> @ 266 nm 1 J/cm <sup>2</sup> @ 532 nm	10 ns pulse width Tested for 266 and 532 nm filters only ( <i>see page 76</i> )
Clear Aperture	≥ 22 mm (or ≥ 45 mm)	
Outer Diameter	25.0 + 0.0 / - 0.1 mm (or 50.0 + 0.0 / - 0.1 mm)	Black-anodized aluminum ring
Overall Thickness	3.5 ± 0.1 mm	Black-anodized aluminum ring
Beam Deviation	≤ 10 arc seconds	

<sup>(1)</sup> For small angles (in degrees), the wavelength shift near the laser wavelength is  $\Delta\lambda$  (nm) =  $-5.0 \times 10^{-5} \times \lambda_L \times \theta^2$  and the wavenumber shift is  $\Delta(\text{wavenumbers})$  (cm<sup>-1</sup>) =  $500 \times \theta^2 / \lambda_L$ , where  $\lambda_L$  (in nm) is the laser wavelength. *See technical note on wavenumbers on page 69.*

## Dichroic Beamsplitter Specifications

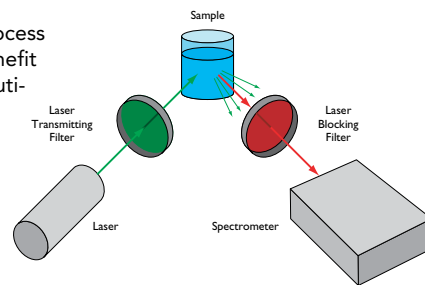
Property	Specification	Comment
Edge Steepness (typical)	0.5% of laser wavelength (2.5 nm or 90 cm <sup>-1</sup> for 532 nm filter)	Measured from 5% to 50% transmission for light with average polarization
Transition Width	"U-grade"	< 1% of laser wavelength
	"S-grade"	< 2% of laser wavelength
Reflection at Laser Wavelength	> 98% (s-polarization) > 90% (p-polarization)	
Average Passband Transmission	> 93%	Averaged over the Passband ( <i>Passband wavelengths detailed on page 62</i> )
Dependence of Wavelength on Angle of Incidence (Edge Shift)	0.35% / degree	Linear relationship valid between about 40° & 50°
Cone Half Angle (for non-collimated light)	< 0.5°	Rays uniformly distributed and centered at 45°
Size of Round Dichroics	Clear Aperture	≥ 22 mm
	Outer Diameter	25.0 + 0.0 / - 0.1 mm
	Overall Thickness	3.5 ± 0.1 mm
Size of Rectangular Dichroics	Clear Aperture	> 80%
	Size	25.2 mm x 35.6 mm (± 0.1 mm)
	Thickness	2.0 ± 0.1 mm
Wedge Angle	≤ 20 arc seconds	
Flatness	Reflection of a collimated, gaussian laser beam with waist diameter up to 3 mm causes less than one Rayleigh Range of focal shift after a focusing lens.	

## General Specifications (all RazorEdge filters)

Property	Specification	Comment
Coating Type	"Hard" ion-beam-sputtered	
Reliability and Durability	Ion-beam-sputtered, hard-coated technology with epoxy-free, single-substrate construction for unrivaled filter life. RazorEdge filters are rigorously tested and proven to MIL-STD-810F and MIL-C-48497A environmental standards.	
Transmitted Wavefront Error	< $\lambda / 4$ RMS at $\lambda = 633$ nm	Peak-to-valley error < 5 x RMS measured within clear aperture
Surface Quality	60-40 scratch-dig	
Temperature Dependence	< 5 ppm / °C	
Substrate Material	Ultra-low autofluorescence fused silica (NBK7 or equivalent for LP01 filters)	
Filter Orientation	For mounted filters, arrow on ring indicates preferred direction of propagation of transmitted light. For rectangular dichroics, reflective coating side should face toward light source and sample	

## Filter Types for Raman Spectroscopy Applications

Raman spectroscopy is widely used today for applications ranging from industrial process control to laboratory research to bio/chemical defense measures. Industries that benefit from this highly specific analysis technique include the chemical, polymer, pharmaceutical, semiconductor, gemology, computer hard disk, and medical fields. In Raman spectroscopy, an intense laser beam is used to create Raman (inelastic) scattered light from a sample under test. The Raman "finger print" is measured by a dispersive or Fourier Transform spectrometer.

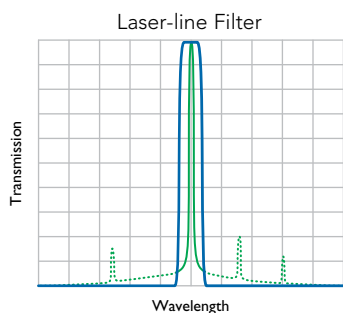


There are three basic types of Raman instrumentation. Raman microscopes, also called micro-Raman spectrophotometers, are larger-scale laboratory analytical instruments for making fast, high-accuracy Raman measurements on very small, specific sample areas. Traditional laboratory Raman spectrometers are primarily used for R&D applications, and range from "home-built" to flexible commercial systems that offer a variety of laser sources, means for holding solid and liquid samples, and different filter and spectrometer types. Finally, a rapidly emerging class of Raman instrumentation is the Raman micro-probe analyzer. These complete, compact and often portable systems are ideal for use in the field or in tight manufacturing and process environments. They utilize a remote probe tip that contains optical filters and lenses, connected to the main unit via optical fiber.

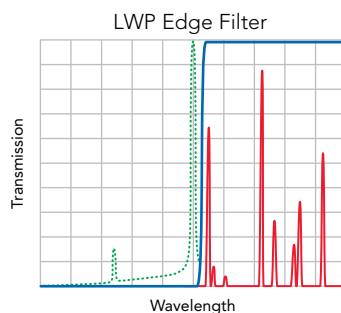
Optical filters are critical components in Raman spectroscopy systems to prevent all undesired light from reaching the spectrometer and swamping the relatively weak Raman signal. Laser Transmitting Filters inserted between the laser and the sample block all undesired light from the laser (such as broadband spontaneous emission or plasma lines) as well as any Raman scattering or fluorescence generated between the laser and the sample (as in a fiber micro-probe system). Laser Blocking Filters inserted between the sample and the spectrometer block the Rayleigh (elastic) scattered light at the laser wavelength.

The illustration above shows a common system layout in which the Raman emission is collected along a separate optical path from the laser excitation path. Systems designed for imaging (e.g., Raman microscopy systems) or with remote fiber probes are often laid out with the excitation and emission paths coincident, so that both may take advantage of the the same fiber and lenses (see *Technical Note on page 58*).

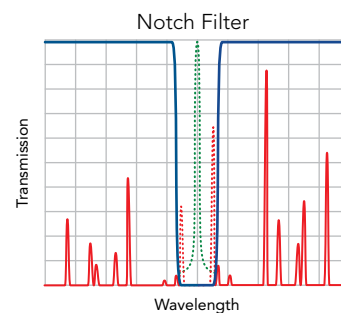
There are three basic types of filters used in systems with separate excitation and emission paths: Laser-line filters, Edge Filters, and Notch Filters. The examples below show how the various filters are used. In these graphs the blue lines represent the filter transmission spectra, the green lines represent the laser spectrum, and the red lines represent the Raman signal (not to scale).



Laser-transmitting filter for both Stokes and Anti-Stokes measurements



Laser-blocking steep edge filter for superior Stokes measurements



Versatile laser-blocking notch filter for both Stokes and Anti-Stokes measurements

Laser-Line Filters are ideal for use as Laser Transmitting Filters, and Notch Filters are an obvious choice for Laser Blocking Filters. In systems using these two filter types, both Stokes and Anti-Stokes Raman scattering can be measured simultaneously. However, in many cases Edge Filters provide a superior alternative to notch filters. For example, a long-wave-pass (LWP) Edge Filter used as a Laser Blocking Filter for measuring Stokes scattering offers better transmission, higher laser-line blocking, and the steepest edge performance to see Raman signals extremely close to the laser line. For more details on choosing between edge filters and notch filters, see the *Technical Note "Edge Filters vs. Notch Filters for Raman Instrumentation" on page 70*.

In systems with a common excitation and emission path, the laser must be introduced into the path with an optic that also allows the Raman emission to be transmitted to the detection system. A 45° dichroic beamsplitter is needed in this case. If this beamsplitter is not as steep as the edge filter or laser-line filter, the ability to get as close to the laser line as those filters allow is lost.

Only Semrock stocks high-performance MaxLine® Laser-line filters (see page 65), RazorEdge® long-wave-pass and short-wave-pass filters (see pages 59 and 61), EdgeBasic™ value long-wave-pass filters (see page 58), ultrasteep RazorEdge Dichroic™ beamsplitter filters (see page 62), and StopLine® notch filters (see page 71) as standard catalog products. Non-standard wavelengths and specifications for these filters are routinely manufactured for volume OEM applications.

# MaxLine® Laser-line Filters

Extensive selection.  
Custom-sized filters are available in one week.

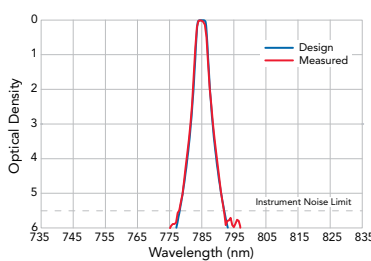
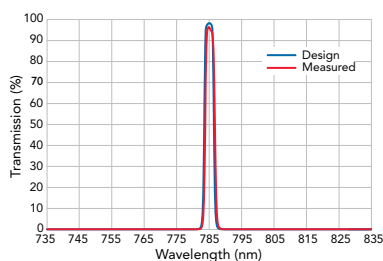
Semrock MaxLine Laser-line Filters have an unprecedented high transmission exceeding 90% at the laser line, while rapidly rolling off to an optical density (OD) > 5 at wavelengths differing by only 1% from the laser wavelength, and OD > 6 at wavelengths differing by only 1.5% from the laser wavelength. U.S. patent No. 7,119,960.



- ▶ Highest laser-line transmission – stop wasting expensive laser light
- ▶ Steepest edges – perfect match to RazorEdge® filters (see page 59)
- ▶ Ideal complement to StopLine® deep notch filters for fluorescence and other applications (see page 71)
- ▶ Hard dielectric coatings for proven reliability and durability
- ▶ For diode lasers, use our MaxDiode™ Laser Clean-up filters (see page 68)

**These items ship same day!**

	Wavelength	Guaranteed Transmission	Typical Bandwidth	OD 5 Blue Range (nm)	OD 6 Blue Range (nm)	OD 6 Red Range (nm)	OD 5 Red Range (nm)	12.5 mm Diameter Part Number	25 mm Diameter Part Number
Ultraviolet	248.6 nm	> 40%	1.7 nm	228.2-246.1	228.7-244.9	252.3-273.5	251.1-279.9	LL01-248-12.5	LL01-248-25
	266.0 nm	> 55%	1.9 nm	242.8-263.3	244.7-262.0	270.0-292.6	268.7-302.2	LL01-266-12.5	LL01-266-25
	325.0 nm	> 80%	1.2 nm	291.0-321.8	299.0-320.1	329.9-357.5	328.3-380.7	LL01-325-12.5	LL01-325-25
	355.0 nm	> 80%	1.3 nm	314.8-351.5	326.6-349.7	360.3-390.5	358.6-422.5	LL01-355-12.5	LL01-355-25
	363.8 nm	> 85%	1.4 nm	321.7-360.2	334.7-358.3	369.3-400.2	367.4-435.0	LL01-364-12.5	LL01-364-25
	372.0 nm	> 85%	1.4 nm	328.1-368.3	342.0-366.4	377.6-409.2	375.7-446.8	LL01-372-12.5	LL01-372-25
Visible	441.6 nm	> 90%	1.7 nm	381.0-437.2	406.3-435.0	448.2-485.8	446.0-551.1	LL01-442-12.5	LL01-442-25
	457.9 nm	> 90%	1.7 nm	393.1-453.3	421.3-451.0	464.8-503.7	462.5-576.7	LL01-458-12.5	LL01-458-25
	488.0 nm	> 90%	1.9 nm	415.1-483.1	449.0-480.7	495.3-536.8	492.9-625.3	LL01-488-12.5	LL01-488-25
	514.5 nm	> 90%	2.0 nm	434.1-509.4	473.3-506.8	522.2-566.0	519.6-669.5	LL01-514-12.5	LL01-514-25
	532.0 nm	> 90%	2.0 nm	446.5-526.7	489.4-524.0	540.0-585.2	537.3-699.4	LL01-532-12.5	LL01-532-25
	543.5 nm	> 90%	2.1 nm	454.6-538.1	500.0-535.3	551.7-597.9	548.9-719.5	LL01-543-12.5	LL01-543-25
	561.4 nm	> 90%	2.1 nm	467.0-555.8	516.5-553.0	569.8-617.5	567.0-751.2	LL02-561-12.5	LL02-561-25
	568.2 nm	> 90%	2.2 nm	471.7-562.5	522.7-559.7	576.7-625.0	573.9-763.4	LL01-568-12.5	LL01-568-25
	632.8 nm	> 90%	2.4 nm	515.4-626.5	582.2-623.3	642.3-696.1	639.1-884.7	LL01-633-12.5	LL01-633-25
	647.1 nm	> 90%	2.5 nm	524.8-640.6	595.3-637.4	656.8-711.8	653.6-912.9	LL01-647-12.5	LL01-647-25
Near-Infrared	671.0 nm	> 90%	2.6 nm	540.4-664.3	617.3-660.9	681.1-738.1	677.7-961.2	LL01-671-12.5	LL01-671-25
	780.0 nm	> 90%	3.0 nm	609.0-772.2	717.6-768.3	791.7-858.0	787.8-1201.8	LL01-780-12.5	LL01-780-25
	785.0 nm	> 90%	3.0 nm	612.0-777.2	722.2-773.2	796.8-863.5	792.9-1213.8	LL01-785-12.5	LL01-785-25
	808.0 nm	> 90%	3.1 nm	625.9-799.9	743.4-795.9	820.1-888.8	816.1-1033.5	LL01-808-12.5	LL01-808-25
	830.0 nm	> 90%	3.2 nm	639.1-821.7	763.6-817.6	842.5-913.0	838.3-1067.9	LL01-830-12.5	LL01-830-25
	976.0 nm	> 90%	3.7 nm	722.2-966.2	897.9-961.4	990.6-1073.6	985.8-1325.2	LL01-976-12.5	LL01-976-25
	980.0 nm	> 90%	3.7 nm	724.4-970.2	901.6-965.3	994.7-1078.0	989.8-1332.6	LL01-980-12.5	LL01-980-25
	1047.1 nm	> 90%	4.0 nm	963.3-1036.6	963.3-1031.4	1062.8-1151.8	1057.6-1398.6	LL01-1047-12.5	LL01-1047-25
1064.0 nm	> 90%	4.0 nm	978.9-1053.4	978.9-1048.0	1080.0-1170.4	1074.6-1428.9	LL01-1064-12.5	LL01-1064-25	

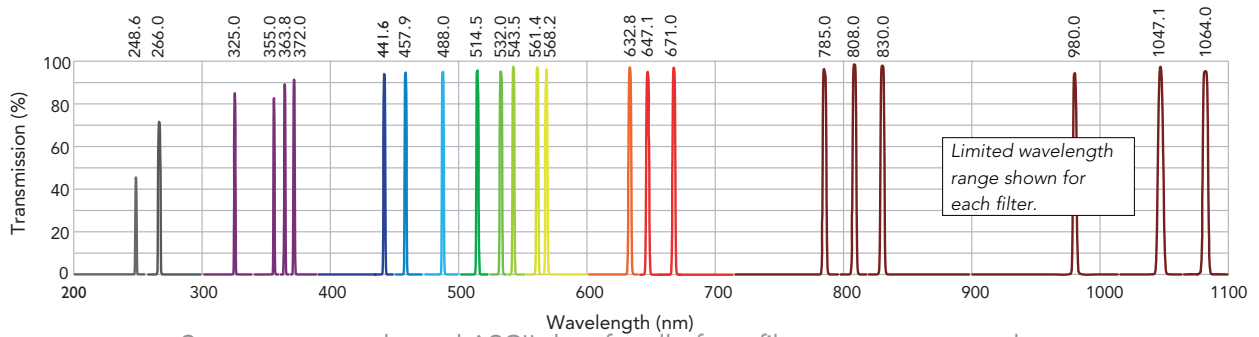


These graphs demonstrate the outstanding performance of the 785 nm MaxLine laser-line filter, which has transmission guaranteed to exceed 90% at the laser line and OD > 5 blocking less than 1% away from the laser line. Note the excellent agreement with the design curves.

# MaxLine® Laser-line Spectra and Specifications

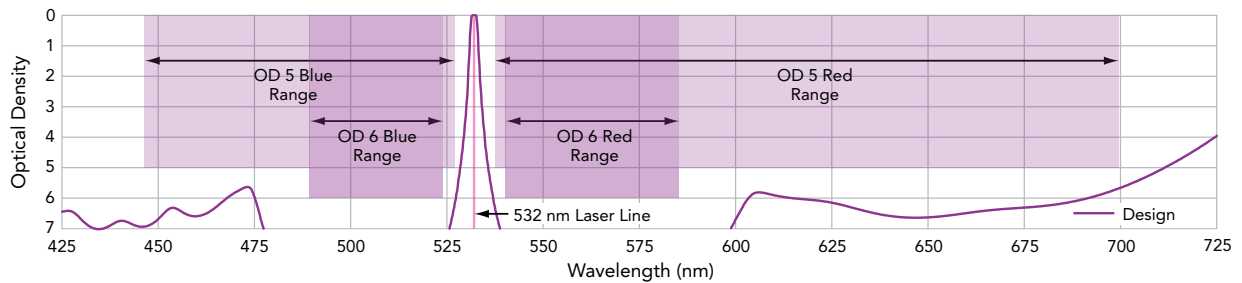
Every Semrock filter is hard-coated for durable performance.  
Five-year warranty.

Actual measured data from typical filters shown



See spectra graphs and ASCII data for all of our filters at [www.semrock.com](http://www.semrock.com)

## MaxLine Filter Blocking Performance (532 nm filter shown)



## Common Specifications

Property	Value	Comment
Laser Wavelength $\lambda_L$	Standard laser wavelengths available	See page 65
Transmission at Laser Line	> 90%	Except $\lambda_L < 400$ nm; Will typically be even higher
Bandwidth	Typical	0.38% of $\lambda_L$
	Maximum	0.7% of $\lambda_L$
Blocking <sup>(1)</sup>	OD > 5 from $\lambda_L \pm 1\%$ to $4500\text{ cm}^{-1}$ (red shift) and $3600\text{ cm}^{-1}$ (blue shift); OD > 6 from $\lambda_L \pm 1.5\%$ to $0.92$ and $1.10 \times \lambda_L$	OD = $-\log_{10}$ (Transmission)
Angle of Incidence	$0.0^\circ \pm 2.0^\circ$	See technical note on page 67
Temperature Dependence	< 5 ppm / °C	< 0.003 nm / °C for 532 nm filter
Laser Damage Threshold	0.1 J/cm <sup>2</sup> @ 532 nm (10 ns pulse width)	Tested for 532 nm filter only (see page 76)
Substrate Material	Low autofluorescence NBK7 or better	Fused silica for 248.6, 266, and 325 nm filters
Coating Type	“Hard” ion-beam-sputtered	
Outer Diameter	12.5 + 0.0 / - 0.1 mm (or 25.0 + 0.0 / - 0.1 mm)	Black-anodized aluminum ring
Overall Thickness	3.5 ± 0.1 mm	Black-anodized aluminum ring
Clear Aperture	≥ 10 mm (or ≥ 22 mm)	For all optical specifications
Transmitted Wavefront Error	< $\lambda / 4$ RMS at $\lambda = 633$ nm	Peak-to-valley error < 5 × RMS
Beam Deviation	≤ 11 arc seconds	
Surface Quality	60-40 scratch-dig	Measured within clear aperture
Reliability and Durability	Ion-beam-sputtered, hard-coating technology with epoxy-free, single-substrate construction for unrivaled filter life. MaxLine filters are rigorously tested and proven to MIL-STD-810F and MIL-C-48497A environmental standards.	

<sup>(1)</sup> The wavelengths associated with these red and blue shifts are given by  $\lambda = 1/(1/\lambda_L - \text{red shift} \times 10^{-7})$  and  $\lambda = 1/(1/\lambda_L + \text{blue shift} \times 10^{-7})$ , respectively, where  $\lambda$  and  $\lambda_L$  are in nm, and the shifts are in  $\text{cm}^{-1}$ . Note that the red shifts are  $3600\text{ cm}^{-1}$  for the 808 and 830 nm filters and  $2700\text{ cm}^{-1}$  for the 980 nm filter, and the red and blue shifts are 2400 and  $800\text{ cm}^{-1}$ , respectively, for the 1047 and 1064 nm filters. See Technical Note on wavenumbers on page 69.

# TECHNICAL NOTE

## Filter Spectra at Non-normal Angles of Incidence

Many of the filters in this catalog (with the exception of dichroic beamsplitters, polarization, and the MaxMirror®) are optimized for use with light at or near normal incidence. However, for some applications it is desirable to understand how the spectral properties change for a non-zero angle of incidence (AOI).

There are two main effects exhibited by the filter spectrum as the angle is increased from normal:

1. the features of the spectrum shift to shorter wavelengths;
2. two distinct spectra emerge – one for s-polarized light and one for p-polarized light.

As an example, the graph at the right shows a series of spectra derived from a typical RazorEdge long-wave-pass (LWP) filter design. Because the designs are so similar for all of the RazorEdge filters designed for normal incidence (see page 59), the set of curves in the graph can be applied approximately to any of the filters. Here the wavelength  $\lambda$  is compared to the wavelength  $\lambda_0$  of a particular spectral feature (in this case the edge location) at normal incidence. As can be seen from the spectral curves, as the angle is increased from normal incidence the filter edge shifts toward shorter wavelengths and the edges associated with s- and p-polarized light shift by different amounts. For LWP filters, the edge associated with p-polarized light shifts more than the edge associated with s-polarized light, whereas for short-wave-pass (SWP) filters the opposite is true. Because of this polarization splitting, the spectrum for unpolarized light demonstrates a “shelf” near the 50% transmission point when the splitting significantly exceeds the edge steepness. However, the edge steepness for polarized light remains very high.

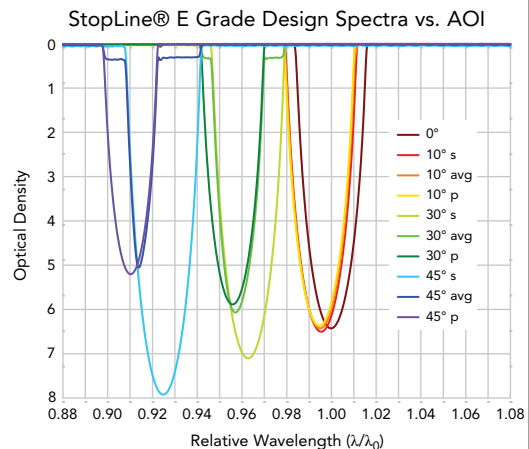
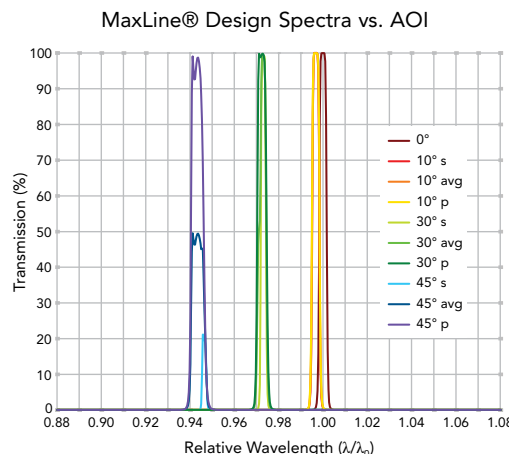
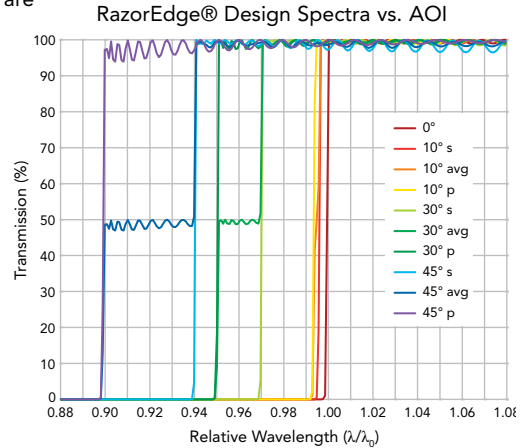
The shift of almost any spectral feature can be approximately quantified by a simple model of the wavelength  $\lambda$  of the feature vs. angle of incidence  $\theta$ , given by the equation:

$$\lambda(\theta) = \lambda_0 \sqrt{1 - (\sin\theta/n_{eff})^2}$$

where  $n_{eff}$  is called the effective index of refraction, and  $\lambda_0$  is the wavelength of the spectral feature of interest at normal incidence. Different shifts that occur for different spectral features and different filters are described by a different effective index. For the RazorEdge example above, the shift of the 90% transmission point on the edge is described by this equation with  $n_{eff} = 2.08$  and  $1.62$  for s- and p-polarized light, respectively.

Other types of filters don't necessarily exhibit such a marked difference in the shift of features for s- and p-polarized light. For example, the middle graph shows a series of spectra derived from a typical MaxLine laser-line filter design curve (see page 65). As the angle is increased from normal incidence, the center wavelength shifts toward shorter wavelengths and the bandwidth broadens slightly for p-polarized light while narrowing for s-polarized light. The center wavelength shifts are described by the above equation with  $n_{eff} = 2.19$  and  $2.13$  for s- and p-polarized light, respectively. The most striking feature is the decrease in transmission for s-polarized light, whereas the transmission remains quite high for p-polarized light.

As another example, the graph at the right shows a series of spectra derived from a typical E-grade StopLine notch filter design curve (see page 71). As the angle is increased from normal incidence, the notch center wavelength shifts to shorter wavelengths; however, the shift is greater for p-polarized light than it is for s-polarized light. The shift is described by the above equation with  $n_{eff} = 1.71$  and  $1.86$  for p- and s-polarized light, respectively. Further, whereas the notch depth and bandwidth both decrease as the angle of incidence is increased for p-polarized light, in contrast the notch depth and bandwidth increase for s-polarized light. Note that it is possible to optimize the design of a notch filter to have a very deep notch even at a 45° angle of incidence.



# MaxDiode™ Laser Diode Clean-up Filters

Every Semrock filter is hard-coated for durable performance.  
Five-year warranty.

Keep the desirable laser light while eliminating the noise. The MaxDiode filters are ideal for both volume OEM manufacturers of laser-based fluorescence instrumentation and laboratory researchers who use diode lasers for fluorescence excitation and other types of spectroscopic applications.

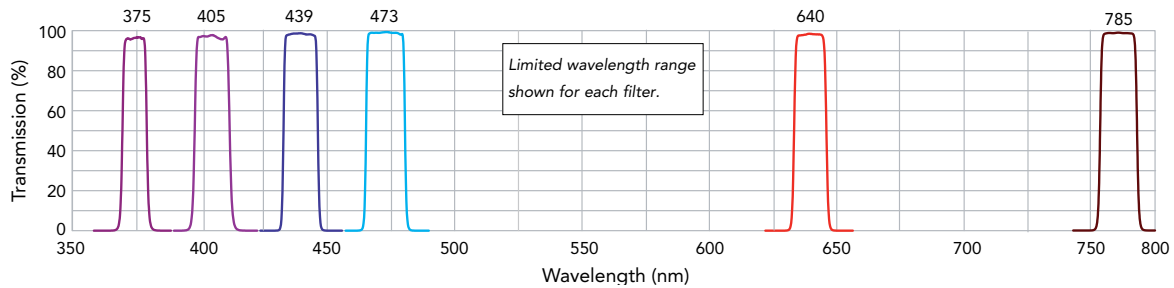


- ▶ **Square low-ripple passband** for total consistency as the laser ages, over temperature, or when replacing a laser
- ▶ Highest transmission, exceeding 90% over each diode's possible laser wavelengths
- ▶ Extremely steep edges transitioning to very high blocking to filter out the undesired out-of-band noise
- ▶ For narrow-line lasers, use our MaxLine laser-line filters (see page 65)

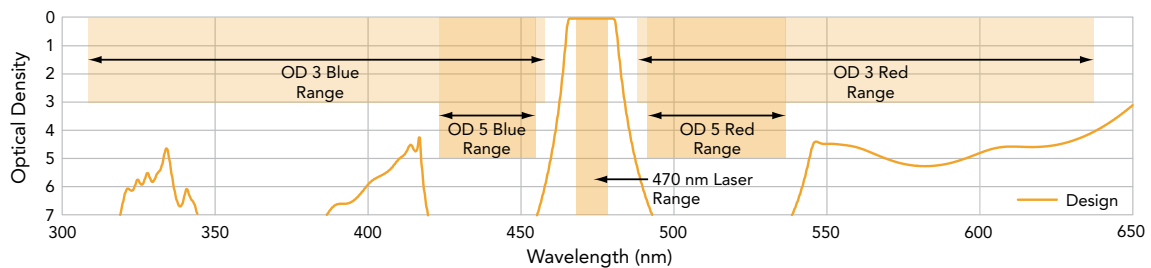
**These items ship same day!**

Laser Diode Wavelength	Transmission & Bandwidth	Center Wavelength	OD 3 Blocking Range	OD 5 Blocking Range	12.5 mm Part Number	25 mm Part Number
375 nm	> 90% over 6 nm	375 nm	212-365 & 385-554 nm	337-359 & 393-415 nm	LD01-375/6-12.5	LD01-375/6-25
405 nm	> 90% over 10 nm	405 nm	358-389 & 420-466 nm	361-384 & 428-457 nm	LD01-405/10-12.5	LD01-405/10-25
440 nm	> 90% over 8 nm	439 nm	281-425 & 453-609 nm	392-422 & 456-499 nm	LD01-439/8-12.5	LD01-439/8-25
470 nm	> 90% over 10 nm	473 nm	308-458 & 488-638 nm	423-455 & 491-537 nm	LD01-473/10-12.5	LD01-473/10-25
640 nm	> 90% over 8 nm	640 nm	400-625 & 655-720 nm	580-622 & 658-717 nm	LD01-640/8-12.5	LD01-640/8-25
785 nm	> 90% over 10 nm	785 nm	475-768 & 800-888 nm	705-765 & 803-885 nm	LD01-785/10-12.5	LD01-785/10-25 <b>New!</b>

Actual measured data shown



MaxDiode Filter Blocking Performance (470 nm filter shown)



## Common Specifications

Property	Value	Comment
Transmission over Full Bandwidth	> 90%	Will typically be even higher
Transmission Ripple	< ± 1.5%	Measured peak-to-peak across bandwidth
Blocking Wavelength Ranges	Optimized to eliminate spontaneous emission	See table above
Angle of Incidence	0.0° ± 5.0°	Range for above optical specifications

Performance for Non-collimated Light: The high-transmission portion of the long-wavelength edge and the low-transmission portion of the short-wavelength edge exhibit a small "blue shift" (shift toward shorter wavelengths). Even for cone half angles as large as 15° at normal incidence, the blue shift is only several nm.

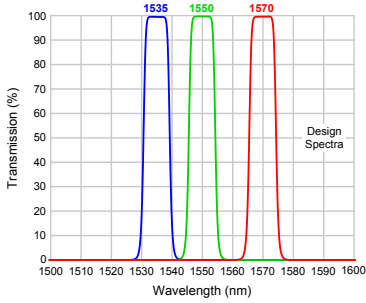
All other mechanical specifications are the same as MaxLine® specifications on page 66.

**New!**

# Near Infrared Bandpass Filters

Extensive selection.

Custom-sized filters are available in one week.



Near-IR bandpass filters are a good match for Er-doped fiber and Er-doped glass lasers at 1535 nm, Er-doped fiber and InGaAsP semiconductor lasers at 1550 nm, and Nd:YAG-pumped optical parametric oscillators (OPO's) at 1570 nm.

**These items ship same day!**

Center Wavelength	Transmission & Bandwidth	Nominal Full-width, Half-Maximum	OD 5 Blocking Range	OD 6 Blocking Range	Part Number
1535 nm	> 90% over 3 nm	6.8 nm	850 – 1519 nm 1550 – 1750 nm	1412 – 1512 nm 1558 – 1688 nm	NIR01-1535/3-25 <b>New!</b>
1550 nm	> 90% over 3 nm	8.8 nm	850 – 1534 nm 1565 – 1750 nm	1426 – 1526 nm 1573 – 1705 nm	NIR01-1550/3-25 <b>New!</b>
1570 nm	> 90% over 3 nm	8.9 nm	850 – 1554 nm 1585 – 1750 nm	1444 – 1546 nm 1593 – 1727 nm	NIR01-1570/3-25 <b>New!</b>

For LDT specifications, see [www.semrock.com](http://www.semrock.com). Except for the transmission, bandwidth, and blocking specifications listed above, all other specifications are identical to MaxLine® specifications on page 66.

For graphs, ASCII data and blocking information, go to [www.semrock.com](http://www.semrock.com)

## TECHNICAL NOTE

### Measuring Light with Wavelengths and Wavenumbers

The “color” of light is generally identified by the distribution of power or intensity as a function of wavelength  $\lambda$ . For example, visible light has a wavelength that ranges from about 400 nm to just over 700 nm. However, sometimes it is convenient to describe light in terms of units called “wavenumbers,” where the wavenumber  $w$  is typically measured in units of  $\text{cm}^{-1}$  (“inverse centimeters”) and is simply equal to the inverse of the wavelength:

$$w (\text{cm}^{-1}) = \frac{10^7}{\lambda (\text{nm})}$$

In applications like Raman spectroscopy, often both wavelength and wavenumber units are used together, leading to potential confusion. For example, laser lines are generally identified by wavelength, but the separation of a particular Raman line from the laser line is generally given by a “wavenumber shift”  $\Delta w$ , since this quantity is fixed by the molecular properties of the material and independent of which laser wavelength is used to excite the line.

When speaking of a “shift” from a first known wavelength  $\lambda_1$  to a second known wavelength  $\lambda_2$ , the resulting wavelength shift  $\Delta\lambda$  is given by

$$\Delta\lambda = \lambda_2 - \lambda_1$$

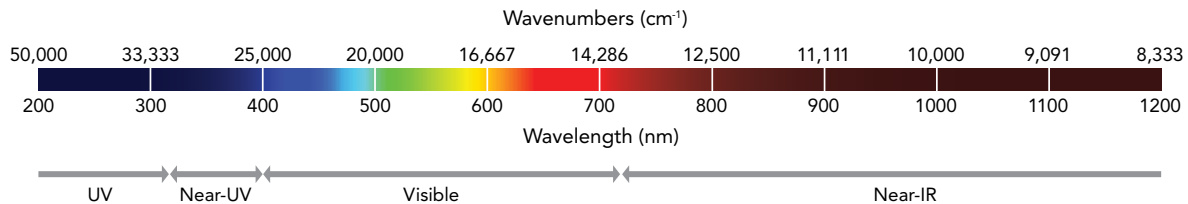
whereas the resulting wavenumber shift  $\Delta w$  is given by

$$\Delta w = \left( \frac{1}{\lambda_2} - \frac{1}{\lambda_1} \right) \times 10^7 = - \frac{\Delta\lambda}{\lambda_1 \lambda_2} \times 10^7$$

When speaking of a known wavenumber shift  $\Delta w$  from a first known wavelength  $\lambda_1$ , the resulting second wavelength  $\lambda_2$  is given by

$$\lambda_2 = \frac{1}{1/\lambda_1 + \Delta w \times 10^{-7}}$$

Note that when the final wavelength  $\lambda_2$  is longer than the initial wavelength  $\lambda_1$ , which corresponds to a “red shift,” in the above equations  $\Delta w < 0$ , consistent with a shift toward smaller values of  $w$ . However, when the final wavelength  $\lambda_2$  is shorter than the initial wavelength  $\lambda_1$ , which corresponds to a “blue shift,”  $\Delta w > 0$ , consistent with a shift toward larger values of  $w$ .



# MaxLamp™ Mercury Line Filters

Every Semrock filter is hard-coated for durable performance.  
Five-year warranty.

These ultrahigh-performance MaxLamp mercury line filters are ideal for use with high-power mercury arc lamps for applications including spectroscopy, optical metrology, and photolithography mask-aligner and stepper systems. Maximum throughput is obtained by careful optimization of the filter design to allow for use in a variety of different applications. The non-absorbing blocking ensures that all other mercury lines as well as intra-line intensity are effectively eliminated.

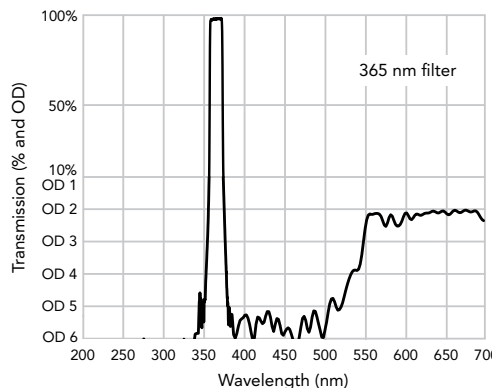
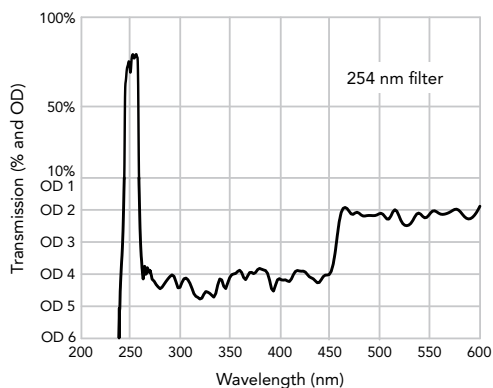


- High transmission > 65% in the UV and > 93% in the Near-UV
- Steep edges for quick transitions
- Exceptional blocking over large portions of visible spectrum

**These items ship same day!**

Mercury Line	Transmission and Passband	UV Blocking	Blue Blocking	Red Blocking	25 mm Diameter Part Number	50 mm Diameter Part Number
253.7 nm	> 65% 244 - 256 nm	OD <sub>avg</sub> > 6: 200 - 236 nm	OD <sub>avg</sub> > 4: 263 - 450 nm	OD <sub>avg</sub> > 2: 450 - 600 nm	Hg01-254-25	Hg01-254-50
365.0 nm	> 93% 360 - 372 nm	OD <sub>avg</sub> > 6: 200 - 348 nm	OD <sub>avg</sub> > 5: 382 - 500 nm	OD <sub>avg</sub> > 2: 500 - 700 nm	Hg01-365-25	Hg01-365-50

Actual measured data shown



## Common Specifications

Property	Value	Comment
Guaranteed Transmission	253.7 nm > 65%	Averaged over the passband, <i>see table above</i>
	365.0 nm > 93%	
Angle of Incidence	0° ± 7°	Range of angles over which optical specifications are given for collimated light
Cone Half Angle	10°	For uniformly distributed non-collimated light
Autofluorescence	Ultra-low	Fused silica substrate
Outer Diameter	25.0 + 0.0 / - 0.1 mm (or 50.0 + 0.0 / - 0.1 mm)	Black anodized aluminium ring
Overall Thickness	3.5 mm ± 0.1mm	Black anodized aluminium ring
Clear Aperture	≥ 22 mm (or ≥ 45 mm)	For all optical specifications
Surface Quality	80-50 scratch-dig	Measured within clear aperture

All other mechanical specifications are the same as MaxLine® specifications on page 66.



# StopLine® Single-notch Filters

Extensive selection.  
Custom-sized filters are available in one week.

StopLine deep notch filters rival the performance of holographic notch filters but in a less expensive, more convenient, and more reliable thin-film filter format (U.S. Patents No. 7,123,416 and pending). These filters are ideal for applications including Raman spectroscopy, laser-based fluorescence instruments, and biomedical laser systems.

- ▶ The stunning StopLine E-grade notch filters offer high transmission over ultra-wide passbands (UV to 1600 nm)
- ▶ Deep laser-line blocking for maximum laser rejection ( $OD > 6$ )
- ▶ High laser damage threshold and proven reliability
- ▶ Rejected light is reflected, for convenient alignment and best stray-light control
- ▶ Multi-notch filters are available for blocking multiple laser lines (see page 73)

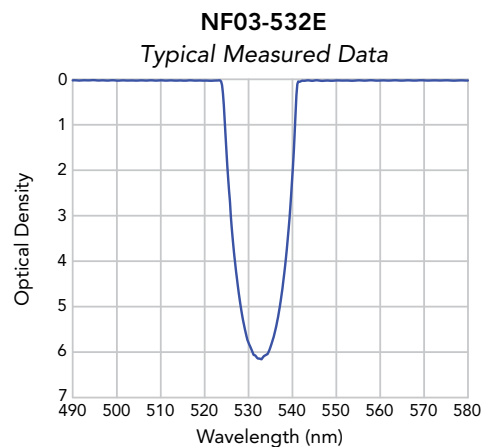
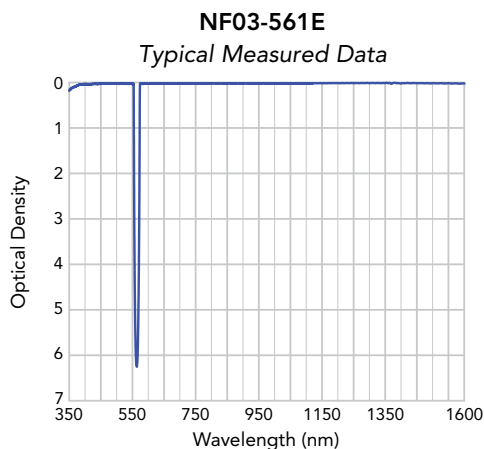
Semrock introduced a breakthrough invention in thin-film optical filters: our StopLine “E-grade” thin-film notch filters have ultrawide passbands with deep and narrow laser-line blocking. Unheard of previously in a thin-film notch filter made with multiple, discrete layers, these new patent-pending notch filters attenuate the laser wavelength with  $OD > 6$  while passing light from the UV well into the near-infrared (1600 nm). They are especially suited for optical systems addressing multiple regions of the optical spectrum (e.g., UV, Visible, and Near-IR), and for systems based on multiple detection modes (e.g., fluorescence, Raman spectroscopy, laser-induced breakdown spectroscopy, etc.).

**These items ship same day!**

Wavelength	Passband Range	Typical 50% Notch Bandwidth	Laser-line Blocking	Part Number
405.0 nm	330.0 – 1600.0 nm 330.0 – 540.0 nm	9 nm 12 nm	OD > 6 OD > 4	NF03-405E-25 NF02-405S-25
441.6 nm	331.2 – 588.8 nm 331.2 – 588.8 nm	11 nm 14 nm	OD > 6 OD > 4	NF01-442U-25 NF02-442S-25
488.0 nm	350.0 – 1600.0 nm	14 nm	OD > 6	NF03-488E-25
514.5 nm	385.9 – 686.0 nm	16 nm	OD > 6	NF01-514U-25
526.5 nm	394.9 – 702.0 nm	17 nm	OD > 6	NF01-526U-25
532.0 nm	350.0 – 1600.0 nm 399.0 – 709.3 nm	17 nm 17 nm	OD > 6 OD > 6	NF03-532E-25 NF01-532U-25
561.4 nm	350.0 – 1600.0 nm	19 nm	OD > 6	NF03-561E-25
568.2 nm	426.2 – 757.6 nm	20 nm	OD > 6	NF01-568U-25
594.1 nm	445.6 – 792.1 nm 445.6 – 792.1 nm	22 nm 25 nm	OD > 6 OD > 4	NF01-594U-25 NF02-594S-25
632.8 nm	350.0 – 1600.0 nm	25 nm	OD > 6	NF03-633E-25
785.0 nm	350.0 – 1600.0 nm 588.8 – 1046.7 nm	39 nm 39 nm	OD > 6 OD > 6	NF03-785E-25 NF01-785U-25
808.0 nm	350.0 – 1600.0 nm 606.0 – 1077.3 nm	41 nm 41 nm	OD > 6 OD > 6	NF03-808E-25 NF01-808U-25
830.0 nm	622.5 – 1106.7 nm	44 nm	OD > 6	NF01-830U-25

**New!**

Looking for a 1064 nm notch filter? Try the NF03-532/1064E on page 73.



# StopLine® Single-notch Filter Common Specifications

Every Semrock filter is hard-coated for durable performance.  
Five-year warranty.

Property	Value	Comment
Laser Line Blocking:	"E" & "U" grade	> 6 OD
	"S" grade	> 4 OD
Typical 50% Notch Bandwidth	"E" & "U" grade	NBW = $55 \times 10^{-6} \times \lambda_L^2 + 14 \times 10^{-3} \times \lambda_L - 5.9$ e.g. 17 nm (600 cm <sup>-1</sup> ) for 532.0 nm filter
	"S" grade	NBW = $10 \times 10^{-5} \times \lambda_L^2 - 29 \times 10^{-3} \times \lambda_L + 7.2$ e.g. 20 nm (700 cm <sup>-1</sup> ) for 532.0 nm filter
Maximum 50% Notch Bandwidth	< 1.1 × NBW	
90% Notch Bandwidth	< 1.3 × NBW <sup>[1]</sup>	Full width at 90% transmission
Passband	"E" grade	350 – 1600 nm
	"U" & "S" grade	from $0.75 \times \lambda_L$ to $\lambda_L / 0.75$ <sup>[1]</sup>
Average Passband Transmission	"E" grade	> 80% 350 – 400 nm, > 93% 400 – 1600 nm
	"U" & "S" grade	> 90%
Passband Transmission Ripple	< 2.5%	Calculated as standard deviation
Angle of Incidence	0.0° ± 5.0°	See technical note on page 67
Angle Tuning Range <sup>[2]</sup>	– 1% of laser wavelength (– 5.3 nm or + 190 cm <sup>-1</sup> for 532 nm filter)	Wavelength "blue-shift" attained by increasing angle from 0° to 14°
Laser Damage Threshold	1 J/cm <sup>2</sup> @ 532 nm (10 ns pulse width)	Tested for 532 nm filter only (see page 76)
Coating Type	"Hard" ion-beam-sputtered	
Clear Aperture	≥ 22 mm	For all optical specifications
Outer Diameter	25.0 + 0.0 / – 0.1 mm	Black-anodized aluminum ring
Overall Thickness	3.5 ± 0.1 mm	

All other General Specifications are the same as the RazorEdge® specifications on the bottom of page 63.

<sup>[1]</sup> For NF02-405 filter, 90% bandwidth is < 1.3 × Maximum 50% Bandwidth, and Passband short wavelength is 330 nm.

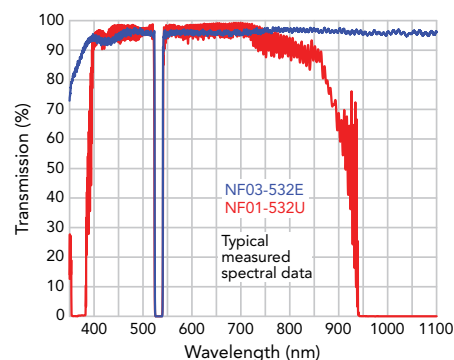
<sup>[2]</sup> For small angles  $\theta$  (in degrees), the wavelength shift near the laser wavelength is  $\Delta\lambda$  (nm) =  $-5.0 \times 10^{-5} \times \lambda_L \times \theta^2$  and the wavenumber shift is  $\Delta(\text{wavenumbers})$  (cm<sup>-1</sup>) =  $500 \times \theta^2 / \lambda_L$ , where  $\lambda_L$  (in nm) is the laser wavelength. See Technical Note on wavenumbers on page 69.

## PRODUCT NOTE

Notch filters are ideal for applications that require nearly complete rejection of a laser line while passing as much non-laser light as possible. Hard-coated thin-film notch filters offer a superior solution due to their excellent transmission (> 90%), deep laser-line blocking (OD > 6) with a narrow notch bandwidth (~ 3% of the laser wavelength), environmental reliability, high laser damage threshold (> 1 J/cm<sup>2</sup>), and compact format with convenient back-reflection of the rejected laser light. However, until now, the main drawback of standard thin-film notch filters has been a limited passband range due to the fundamental and higher-harmonic spectral stop bands (see red curve on graph at right).

To achieve a wider passband than standard thin-film notch filters could provide, optical engineers had to turn to "holographic" or "Rugate" notch filters. Unfortunately, holographic filters suffer from lower reliability and transmission (due to the gelatin-based, laminated structure), higher cost (resulting from the sequential production process), and poorer system noise performance and/or higher system complexity. Rugate notch filters, based on a sinusoidally varying index of refraction, generally suffer from lower transmission, especially at shorter wavelengths, and less deep notches.

Semrock's "E-grade" StopLine notch filters offer a breakthrough in optical notch filter technology, bringing together all the advantages of hard-coated standard thin-film notch filters with the ultrawide passbands that were previously possible only with holographic and Rugate notch filters! The spectral performance of the E-grade StopLine filters is virtually identically to that of Semrock's renowned "U-grade" StopLine filters, but with passbands that extend from the UV (< 350 nm) to the near-IR (> 1600 nm).



# StopLine® Multi-notch Filters

Extensive selection.  
Custom-sized filters are available in one week.

Semrock's unique multi-notch filters meet or exceed even the most demanding requirements of our OEM customers. These include dual-, triple-, and even quadruple-notch filters for a variety of multi-laser instruments. Applications include:

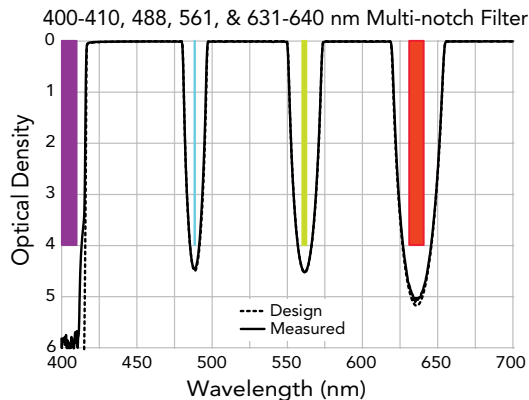
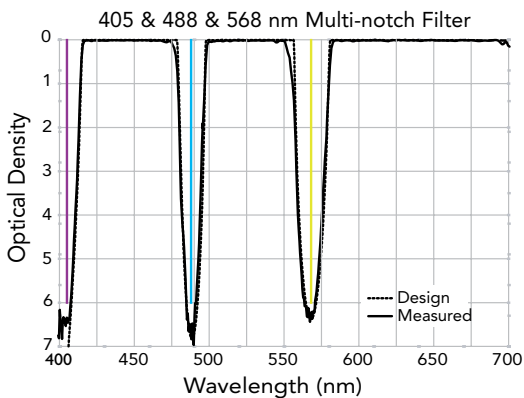
- ▶ Laser-based fluorescence instruments
- ▶ Confocal and multi-photon fluorescence microscopes
- ▶ Analytical and medical laser systems

Our advanced manufacturing process means that these filters can be made with notch wavelengths that are not integer multiples of each other!

**These items ship same day!**

Laser Wavelengths	Laser-line Blocking	Part Number	Dimensions
<b>Dual-notch Filters</b>			
488 & 532 nm	OD > 6	NF01-488/532-25x5.0	25 mm x 5.0 mm
488 & 543 nm	OD > 6	NF01-488/543-25x5.0	25 mm x 5.0 mm
486 – 490 & 631 – 640 nm	OD > 4	NF01-488/635-25x5.0	25 mm x 5.0 mm
488 & 647 nm	OD > 6	NF01-488/647-25x5.0	25 mm x 5.0 mm
<b>532 &amp; 1064 nm</b>	<b>OD &gt; 6</b>	<b>NF03-532/1064E-25</b>	<b>25 mm x 3.5 mm</b>
543 & 647 nm	OD > 6	NF01-543/647-25x5.0	25 mm x 5.0 mm
568 & 638 nm	OD > 6	NF01-568/638-25x5.0	25 mm x 5.0 mm
568 & 647 nm	OD > 6	NF01-568/647-25x5.0	25 mm x 5.0 mm
594 & 638 nm	OD > 6	NF01-594/638-25x5.0	25 mm x 5.0 mm
<b>Triple-notch Filters</b>			
405, 488, & 568 nm	OD > 6	NF01-405/488/568-25	25 mm x 3.5 mm
488, 532, & 631-640 nm	OD > 4	NF01-488/532/635-25x5.0	25 mm x 5.0 mm
<b>Quadruple-notch Filters</b>			
400 – 410, 488, 532, & 631 – 640 nm	OD > 4	NF01-405/488/532/635-25x5.0	25 mm x 5.0 mm
400 – 410, 488, 561, & 631 – 640 nm	OD > 4	NF01-405/488/561/635-25x5.0	25 mm x 5.0 mm

Actual measured data from typical filters is shown

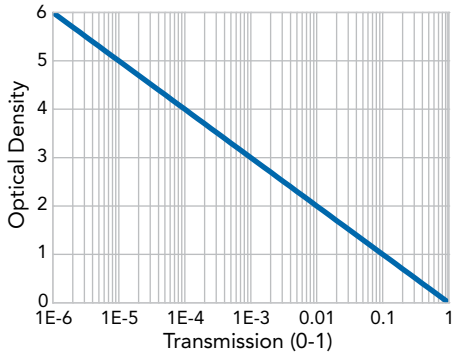


For complete graphs, ASCII data, and the latest offerings, go to [www.semrock.com](http://www.semrock.com).

# TECHNICAL NOTE

## Working with Optical Density

Optical Density – or OD, as it is commonly called – is a convenient tool to describe the transmission of light through a highly blocking optical filter (when the transmission is extremely small). OD is simply defined as the negative of the logarithm (base 10) of the transmission, where the transmission varies between 0 and 1 ( $OD = -\log_{10}(T)$ ). Therefore, the transmission is simply 10 raised to the power of minus the OD ( $T = 10^{-OD}$ ). The graph below left demonstrates the power of OD: a variation in transmission of six orders of magnitude (1,000,000 times) is described very simply by OD values ranging between 0 and 6. The table of examples below middle, and the list of “rules” below right, provide some handy tips for quickly converting between OD and transmission. Multiplying and dividing the transmission by two and ten is equivalent to subtracting and adding 0.3 and 1 in OD, respectively.



Transmission	OD
1	0
0.5	0.3
0.2	0.7
0.1	1
0.05	1.3
0.02	1.7
0.01	2
0.005	2.3
0.002	2.7
0.001	3

- The “1” Rule**  
 $T = 1 \rightarrow OD = 0$

**The “x 2” Rule**  
 $T \times 2 \rightarrow OD - 0.3$

**The “÷ 2” Rule**  
 $T \div 2 \rightarrow OD + 0.3$

**The “x 10” Rule**  
 $T \times 10 \rightarrow OD - 1$

**The “÷ 10” Rule**  
 $T \div 10 \rightarrow OD + 1$

# TECHNICAL NOTE

## Edge Filters vs. Notch Filters for Raman Instrumentation

### RazorEdge® Filter Advantages:

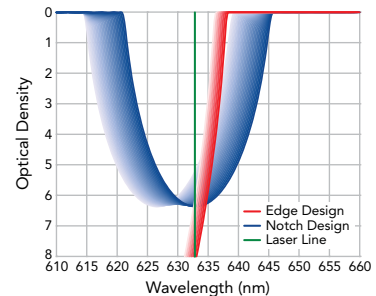
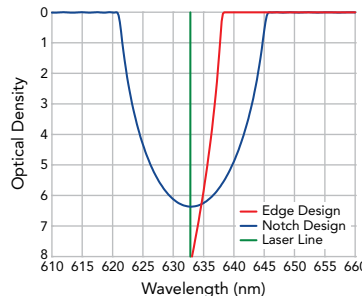
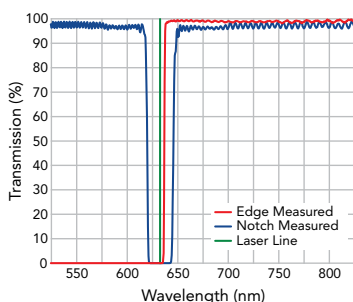
- Steepest possible edge for looking at the smallest Stokes shifts
- Largest blocking of the laser line for maximum laser rejection

### StopLine® Notch Filter Advantages:

- Measure Stokes and Anti-Stokes signals simultaneously
- Greater angle-tunability and bandwidth for use with variable laser lines

The graph below left illustrates the ability of a long-wave-pass (LWP) filter to get extremely close to the laser line. The graph in the center compares the steepness of an edge filter to that of a notch filter. A steeper edge means a narrower transition width from the laser line to the high-transmission region of the filter. With transition widths guaranteed to be below 1% of the laser wavelength (on Semrock U-grade edge filters), these filters don’t need to be angle-tuned!

The graph on the right shows the relative tuning ranges that can be achieved for edge filters and notch filters. Semrock edge filters can be tuned up to 0.3% of the laser wavelength. The filters shift toward shorter wavelengths as the angle of incidence is increased from 0° to about 8°. Semrock notch filters can be tuned up to 1.0% of the laser wavelength. These filters also shift toward shorter wavelengths as the angle of incidence is increased from 0° up to about 14°.



# MaxMirror® Ultra-broadband Mirror

Extensive selection.  
Custom-sized filters are available in one week.

The MaxMirror is a unique high-performance laser mirror that covers an ultra-broad range of wavelengths – it can replace three or more conventional laser mirrors. In fact, it is so unique that it is patented (U.S. patent No. 6,894,838). The MaxMirror is a winner of the prestigious Photonics Circle of Excellence award, reserved for the most innovative new products of the year. And there is still nothing else like it on the market!

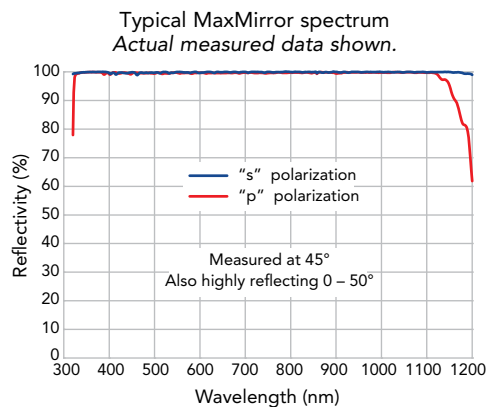


- ▶ **Very highly reflecting over:**
  - ◆ Near-UV, all Visible, and Near-IR wavelengths
  - ◆ All states of polarization
  - ◆ All angles from 0 to 50° inclusive – simultaneously
- ▶ High laser damage threshold and proven reliability
- ▶ Low-scattering



**These items ship same day!**

Diameter	Absolute Surface Flatness	Mirror Side Part Number
25.0 mm	$< \lambda / 10$	MM1-311-25.0
25.4 mm (1.00")	$< \lambda / 10$	MM1-311-25.4
25.4 mm (1.00")	$< \lambda / 5$	MM1-311S-25.4
50.8 mm (2.00")	$< \lambda / 4$	MM1-311-50.8
50.8 mm (2.00")	$< \lambda / 2$	MM1-311S-50.8



## Common Specifications

Property	Value	Comment
Wavelength Range	350 - 1100 nm	<i>All specifications apply</i>
Wide Angle of Incidence Range	0 - 50°	Range over which Wide Angle Reflectivity specifications are met
Wide Angle Reflectivity	> 98.5%	For unpolarized light
	> 98.0%	For "s" polarization
	> 98.0%	For "p" polarization
Standard Angle of Incidence	45.0 ± 2.5° 0.0 ± 5.0°	Range over which Standard Reflectivity specifications are met
Standard Reflectivity	> 99.0%	For unpolarized light
	> 98.5% (> 99% typical)	For "s" polarization
	> 98.5% (> 99% typical)	For "p" polarization
Laser Damage Threshold	1 J/cm <sup>2</sup> @ 355 nm 2 J/cm <sup>2</sup> @ 532 nm 6 J/cm <sup>2</sup> @ 1064 nm	10 ns pulse width. ( <i>see page 76</i> )
Substrate Material	NBK7 or better	
Coating Type	"Hard" ion-beam-sputtered	
Clear Aperture	> 80% of Outer Diameter	
Outer Diameter	25.0 or 25.4 or 50.8 mm + 0.0 / - 0.25 mm	
Thickness	9.52 ± 0.25 mm	Nominally 3/8"
Mirror Side Surface Flatness	See table above	Measured at $\lambda = 633$ nm
Mirror Side Surface Quality	20-10 scratch-dig (standard grade) or 40-20 (S-grade)	Measured within clear aperture
Mirror Side Bevel	0.75 mm maximum	
Pulse Dispersion	The MaxMirror will not introduce appreciable pulse broadening for most laser pulses that are > 1 picosecond; however, pulse distortion is likely for significantly shorter laser pulses, including femtosecond pulses.	
Reliability and Durability	Ion-beam-sputtered, hard-coating technology with unrivaled filter life. MaxMirror ultra-broadband mirrors are rigorously tested and proven to MIL-STD-810F and MIL-C-48497A environmental standards.	

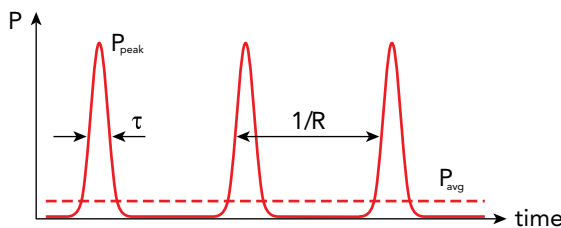
# TECHNICAL NOTE

## Laser Damage Threshold

Laser damage to optical filters is strongly dependent on many factors, and thus it is difficult to guarantee the performance of a filter in all possible circumstances. Nevertheless, it is useful to identify a Laser Damage Threshold (LDT) of pulse fluence or intensity below which no damage is likely to occur.

**Pulsed vs. continuous-wave lasers:** Pulsed lasers emit light in a series of pulses of duration  $\tau$  at a repetition rate  $R$ , with peak power  $P_{\text{peak}}$ . Continuous-wave (cw) lasers emit a steady beam of light with a constant power. Pulsed-laser average power  $P_{\text{avg}}$  and cw laser constant power typically range from several milli-Watts (mW) to Watts (W) for most lasers. The diagram and table below illustrate and summarize the key parameters that are used to characterize the output of pulsed lasers.

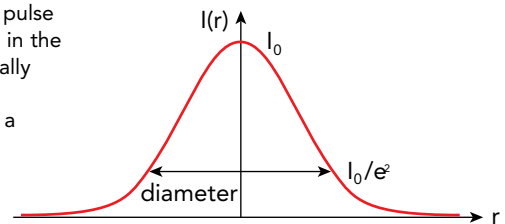
Symbol	Definition	Units	Key Relationships
$\tau$	Pulse duration	sec	$\tau = D / R$
$R$	Repetition rate	Hz = $\text{sec}^{-1}$	$R = D / \tau$
$D$	Duty cycle	dimensionless	$D = R \times \tau$
$P$	Power	Watts = Joules / sec	$P_{\text{peak}} = E / \tau$ ; $P_{\text{avg}} = P_{\text{peak}} \times D$ ; $P_{\text{avg}} = E \times R$
$E$	Energy per pulse	Joules	$E = P_{\text{peak}} \times \tau$ ; $E = P_{\text{avg}} / R$
$A$	Area of laser spot	$\text{cm}^2$	$A = (\pi / 4) \times \text{diameter}^2$
$I$	Intensity	Watts / $\text{cm}^2$	$I = P / A$ ; $I_{\text{peak}} = F / \tau$ ; $I_{\text{avg}} = I_{\text{peak}} \times D$ ; $I_{\text{avg}} = F \times R$
$F$	Fluence per pulse	Joules / $\text{cm}^2$	$F = E / A$ ; $F = I_{\text{peak}} \times \tau$ ; $F = I_{\text{avg}} / R$



Note that because fluence and intensity on the surface of the component are the critical parameters, the area of the laser spot is also critical. Even very high-power lasers may be transmitted through, or reflected off of, a durable optical filter if the spot size is sufficiently large to minimize the fluence and/or intensity. The diameter of a laser spot with a Gaussian profile is most commonly measured at the  $1/e^2$  intensity points as shown in the diagram below.

**Long-pulse lasers:** LDT is perhaps most accurately specified in terms of pulse fluence for "long-pulse lasers." Long-pulse lasers have pulse durations  $\tau$  in the nanosecond (ns) to microsecond (ms) range, with repetition rates  $R$  typically ranging from about 1 to 100 Hz. Because the time between pulses is so large (milliseconds), the irradiated material is able to thermally relax – as a result damage is generally not heat-induced, but rather caused by nearly instantaneous optical field effects. Usually damage results from surface or volume imperfections in the material and the associated irregular optical field properties near these sites, rather than catastrophic destruction of the fundamental material structure. Most Semrock filters

have LDT values on the order of 1 J/cm<sup>2</sup>, and are thus considered "high-power laser quality" components. An important exception is a High-Q laser-line filter in which the internal field strength is strongly magnified, resulting in an LDT that may be an order of magnitude smaller.



As an example, suppose a frequency-doubled Nd:YAG laser at 532 nm emits 10 ns pulses at a 10 Hz repetition rate with 1 W of average power. This laser has a duty cycle of  $1 \times 10^{-7}$ , a pulse energy of 100 mJ, and a peak power of 10 MW. If the beam is focused down to a 100  $\mu\text{m}$  diameter spot on the surface of a component, the pulse fluence is 1.3 kJ/cm<sup>2</sup>, and thus it will almost surely damage a component with a 1 J/cm<sup>2</sup> LDT. However, if the spot diameter is 5 mm, the pulse fluence is only 0.5 J/cm<sup>2</sup>, and thus the component should not be damaged.

**cw lasers:** The LDT for cw lasers is more difficult to measure, and therefore is not specified as often as the long-pulse laser LDT. Damage from cw lasers tends to result from thermal (heating) effects. At this time Semrock does not test nor specify cw LDT for its filters. As a very rough rule of thumb, many all-glass components like dielectric thin-film mirrors and filters have a cw LDT (specified as intensity in kW/cm<sup>2</sup>) that is 10 – 100 times the long-pulse laser LDT (specified as fluence in J/cm<sup>2</sup>).

**Quasi-cw lasers:** Quasi-cw lasers are pulsed lasers with pulse durations  $\tau$  in the femtosecond (fs) to picosecond (ps) range, and with repetition rates  $R$  typically ranging from about 10 – 100 MHz for high-power lasers. These lasers are typically mode-locked, which means that  $R$  is determined by the round-trip time for light within the laser cavity. With such high repetition rates, the time between pulses is so short that thermal relaxation cannot occur. Thus quasi-cw lasers are often treated approximately like cw lasers with respect to LDT, using the average intensity in place of the cw intensity.

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Most catalog items may be custom sized in less than one week. Please contact us directly to discuss your specific needs.

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