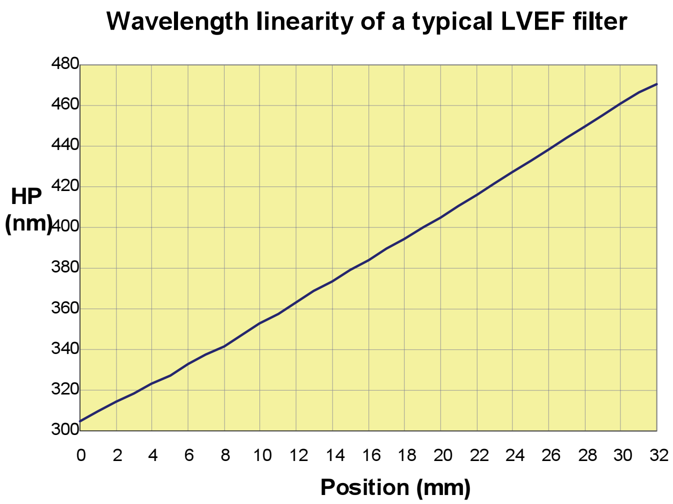
BARR CUSTOM LINEAR VARIABLE INTERFERENCE FILTERS

Barr designs and manufactures both edge-type and bandpass-type variable filters to customer specifications. The key feature of these devices is that spectral properties vary with position in a prescribed way along the lengthwise direction of the filter. It is possible to design this variation to be linear or non-linear, depending upon customer requirements. When the variation is linear the filter is known as a Linear Variable Filter (LVF). Barr Associates, Inc. has capabilities to manufacture variable filters within the spectral range from approximately 300nm in the ultraviolet to approximately 10 microns in the far infrared.

Barr's Linear Variable Edge Filters

A Barr Linear Variable Edge Filter (LVEF) is comprised of an interference filter coating on a glass or fused silica substrate deposited in such a way that the spectral position of the edge varies linearly along the length of the filter.



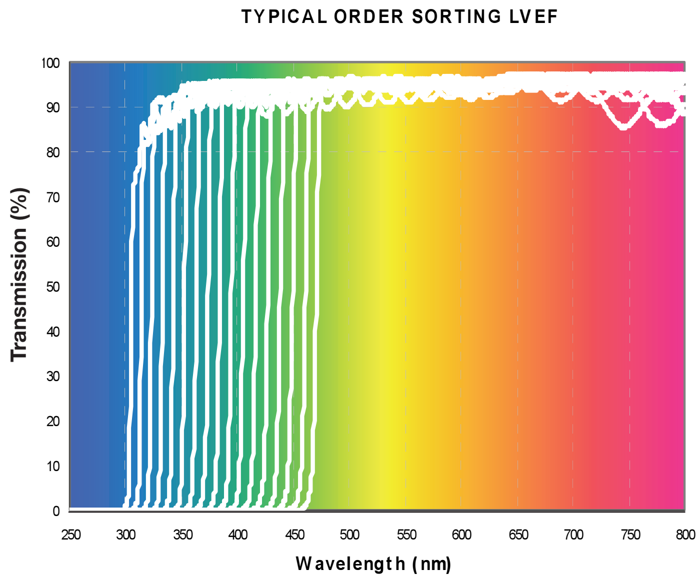
Barr offers LVEF's **manufactured to customer spectral and dimensional specifications.** These filters are made with durable oxide coatings on glass or fused silica substrates. Linear Variable Edge Filters are typically used in grating-based systems as order sorting filters. The LVEF is often placed on the front window of a detector array to suppress second and third order effects.

Spectral Design Range:

Using durable oxide coatings, Barr can design LVEF's within the spectral range from approximately 300nm to 2500nm. A common wavelength range for design of this type of LVF would be 400nm to 700nm.

Linear Dispersion:

For a LVEF the wavelength position of the filter slope or edge (expressed in nm) varies linearly with position (expressed in mm) along the length of the filter.



Linear Dispersion for a LVEF (as expressed in nm/mm) is the slope of wavelength (evaluated at the Half Power Wavelength) as a function of linear position along the filter.

Linear Dispersion (nm/mm) =

$$(HPWL\ 2\ (nm) - HPWL\ 1(nm)) / (X_2\ (mm) - X_1\ (mm))$$

Where:

HPWL 1 = Half Power Wavelength # 1

HPWL 2 = Half Power Wavelength # 2

X_1 = Linear position corresponding to HPWL 1

X_2 = Linear position corresponding to HPWL 2

A typical value for Linear Dispersion in a Barr LVEF is 10 nm / mm.

Linear Dispersion -% Deviation from Linearity:

A measure of the degree of linearity of the Linear Dispersion is the % Deviation from Linearity (expressed as +/- % of the absolute Linear Dispersion.)

For a Barr LVEF with Linear Dispersion of 10nm/mm, a typical value for the % Deviation from Linearity would be +/- 5%.

It should be noted that while Barr can manufacture LVEF's with a dispersion profile that is linear, capability exists to manufacture variable filters where the dispersion (nm/mm) is intentionally made to be non-linear, per customer requirements.

Edge Filter Slope:

For Barr LVEF's the steepness of the edge filter slope can be designed to meet customer requirements. Edge filter slope is expressed as a percentage of the Half Power Wavelength from the 5% absolute transmission point on the edge filter slope to the 80% absolute transmission point.

Edge Filter Slope (%) =

$$[(WL\ @\ 80\%T - WL\ @\ 5\%T) / HPWL] \times 100$$

A typical Edge Filter Slope for a Barr LVEF is 1%.

In-Band Transmission:

For a Barr LVEF a typical transmission level over the first order transmission range would be 90% average, 85% minimum.

Out-of-Band Transmission (Blocking):

With respect to the first order transmission range, effective blocking with the range of 0.1%T to 0.001%T can be afforded over the second and third order transmission ranges.

For a Barr LVEF, typical Out-of-Band Transmission level would be 0.01%T

Filter Dimensions:

Barr can manufacture LVEF's with dimensions to customer specifications.

Current capability allows a maximum filter length of 63.5mm and maximum filter width of 127mm.

A filter thickness of 1mm is typical.

Coating Type:

Barr constructs LVEF's using durable, first-surface, stable oxide coatings.

SubstrateType:

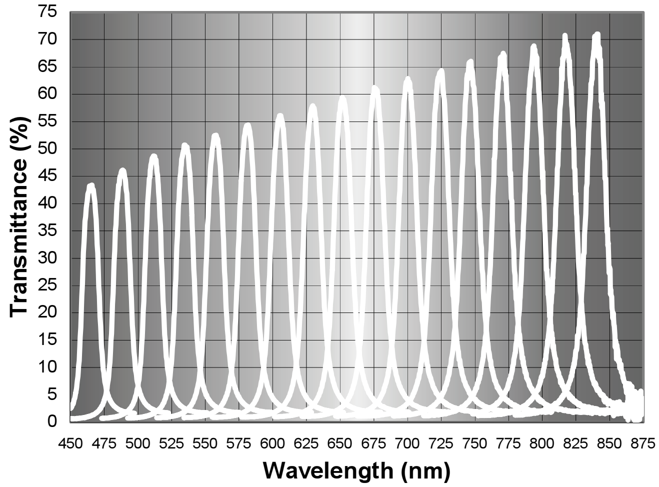
Barr typically manufactures LVEF's using UV-grade fused silica as a substrate material, but other substrate materials could be used as well, depending upon customer requirements.

Environmental Durability:

Since Barr LVEF's are interference filters constructed with durable oxide coatings these filters show excellent environmental durability characteristics. Barr interference filters are often subjected to environmental resistance tests such as those described in MIL-STD-810C, MIL-F-48616, MIL-C-48497A, MIL-C-675, and MIL-STD-13508.

Barr's Linear Variable Bandpass Filters

Barr has the capability to design and produce custom Linear Variable Bandpass Filters (LVBF's). Depending upon customer requirements, effective blocking can be afforded over the second and third order transmission ranges.



Spectral Design Range:

Broad wavelength ranges are typically spanned by use of more than one bandpass-type LVF having different spectral ranges. For example, a LVBF designed to span the wavelength range 400nm to 1000nm would be comprised of two different LVBF's: one spanning 400nm to 650nm and a second spanning 650nm to 1000nm. The complete filter would involve bonding of the long wavelength end of the first filter to the short wavelength end of the second filter.

Linear Dispersion:

For a Barr LVBF the center wavelength position of the filter (expressed in nm) varies linearly with position (expressed in mm) along the length of the filter.

Linear Dispersion for a LVBF (as expressed in nm/mm) is the ratio of wavelength change (evaluated at the Center Wavelength) divided by change in linear position along the filter length.

Linear Dispersion (nm/mm) =

$$(\text{CWL } 2 \text{ (nm)} - \text{CWL } 1\text{(nm)}) / (X_2 \text{ (mm)} - X_1 \text{ (mm)})$$

Where

CWL 1 = Center Wavelength # 1

CWL 2 = Center Wavelength # 2

X_1 = Linear position corresponding to CWL 1

X_2 = Linear position corresponding to CWL 2

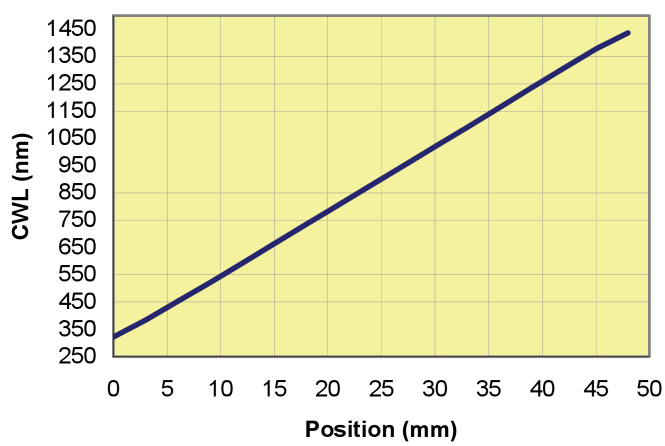
A typical value for Linear Dispersion in a Barr LVBF is 10 nm / mm.

Linear Dispersion -% Deviation from Linearity:

A measure of the degree of linearity of the Linear Dispersion is the % Deviation from Linearity (expressed as +/- % of the absolute Linear Dispersion.

For a Barr LVBF with Linear Dispersion of 10nm/mm a typical value for the % Deviation from Linearity would be +/- 5%.

It should be noted that while Barr can manufacture LVBF's with a linear dispersion profile, capability exists to manufacture Variable Filters where the dispersion (nm/mm) is intentionally made to be non-linear, per customer requirements.



Bandwidth:

For Barr LVBF's the FWHM bandwidth (nm) typically is 2% to 3% of the Center Wavelength of the pass band. Typically Barr would use a 3-cavity bandpass filter design. Since dispersion associated with the coating deposition materials causes there to be some variation in bandwidth as a function of center wavelength the typical FWHM bandwidth values stated above represent values for the center of the wavelength range.

In-Band Transmission:

For a Barr LVBF a typical transmission level for the pass band would be 85% minimum.

Out-of-Band Transmission (blocking):

With respect to the first order transmission range, effective blocking within the range of 0.1%T to 0.001%T can be afforded over the second and third order transmission ranges.

For a LVBF a typical Out-of-Band Transmission level would be 0.01%T

Filter Dimensions:

Barr can manufacture LVBF's with dimensions to customer specifications.

Current capability allows a maximum filter length of 63.5mm and maximum filter width of 127mm.

A filter thickness of < 5mm is typical.

Coating type:

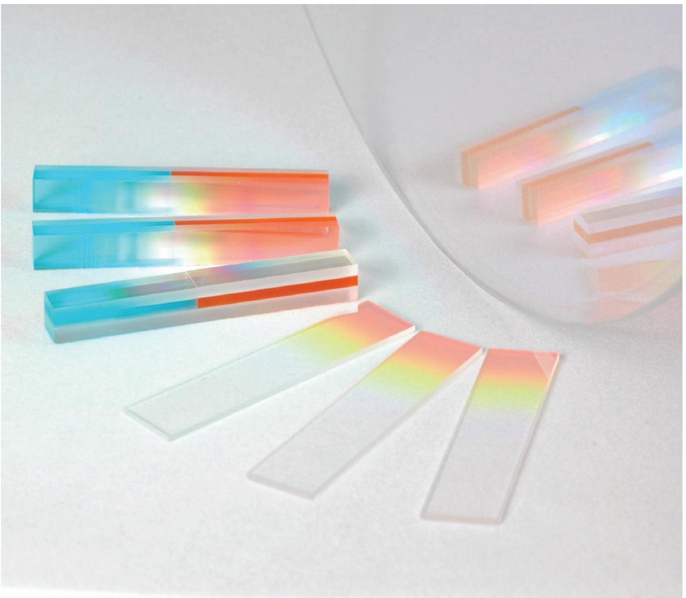
Barr constructs LVBF's using durable, first-surface, stable oxide coatings.

SubstrateType:

Barr commonly manufactures LVBF's using UV-grade fused silica as a substrate material. Sometimes, depending upon customer requirements, laminated constructions are used involving multiple, coated substrates and selected absorption glasses.

Environmental Durability:

Since Barr LVBF's are interference filters constructed with durable oxide coatings these filters show excellent environmental durability characteristics. Barr interference filters are often subjected to environmental resistance tests such as those described in MIL-STD-810C, MIL-F-48616, MIL-C-48497A, MIL-C-675, and MIL-STD-13508.



BARR ASSOCIATES, INC.

Relationships Through Technical Excellence and Integrity

USA:
Barr Associates, Inc.
2 Lyberty Way Westford MA 01886
phone: 978-692-7513
fax: 978-692-7443
e-mail: barr@barrassociates.com
Website: www.barrassociates.com

UK Subsidiary :
Barr UK 3&4 Home Farm Business Units
Yattendon, Newbury
RG18 0XT, United Kingdom
Phone: + 44 (0) 1635-201-317
Fax: +44 (0) 1635-202-030
Email: awhatley@barr-associates-uk.com
Website: www.barr-associates-uk.com

Japan:
Fujitok Corp.
1-9-16, Kami-Jujo
Kita-Ku, Tokyo 114-0034 Japan
Phone: 81-3-3909-1791
Fax: 81-3-3908-6450
Website: www.fujitok.co.jp