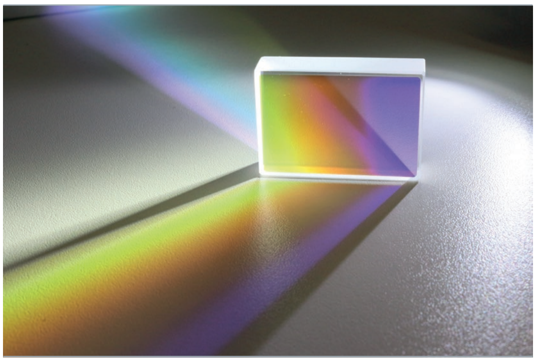
Linear Variable Filters (LVFs)

LVFs for Biophotonics, Spectroscopy and Hyperspectral Imaging



Some applications may benefit from using Linear Variable Filters (LVFs) instead of conventional optical filters, which exhibit distinct transmission and blocking bands uniformly across their whole surface. In contrast, LVFs provide continuously variable transmission characteristics across their surface. For instance, such a filter might transmit the whole visible spectrum on one end while selectively allowing only the red spectrum to pass through on the other end (Fig. 1). Users can adjust their required transmission characteristic simply by altering the position of illumination on the filter, winning more flexibility. LVFs especially excel in applications requir-ing precise wavelength control, such as spectroscopy and hyperspectral imaging. They should also be considered in sophisticated optical setups requiring multiple wavelength bands, such as in fluorescence applications.

Benefits

- High versatility
- Wide range of variable filter types
- Deep blocking by reflectance, low absorption
- High transmittance in the pass range
- Long-term shift-free spectral performance
- High environmental stability
- Customized dispersion
- Customized filter sizes

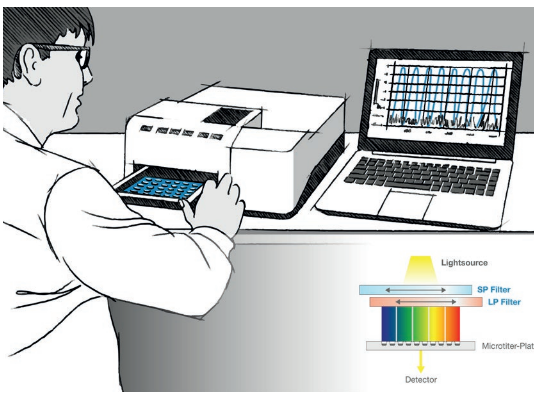
Applications

Linear variable filters (LVFs) are utilized in numerous optical fields such as spectroscopy, hyperspectral imaging (HSI), and fluorescence microscopy. LVFs are advantageous in applications that require lightweight and compact instruments, such as HSI devices installed on unmanned aerial vehicles (UAVs), which are increasingly utilized in agriculture or for environmental observations. LVFs are also applied as wavelength selectors, order sorting filters in grating-based systems, or in purely filter-based spectrometers.

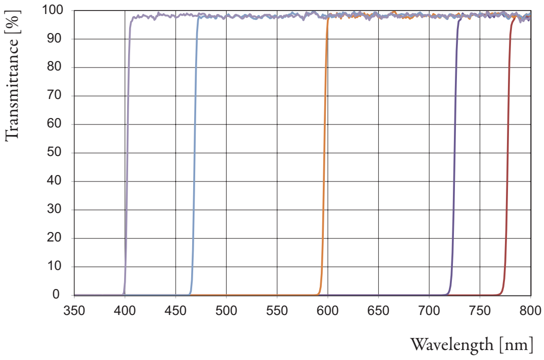
Technical Data

Filter type	Longpass, Shortpass, Bandpass Further types available on request
Wavelength range	as per customer request, e.g. from 400 nm to 800 nm from 380 nm to 1100 nm from 1100 nm to 1700 nm
Transmittance	T > 90 – 97% (depending on wavelength range)
Blocking	up to OD8 (according to requirements)
Reflectance	R > 90 – 99%
Angle of Incidence	standard 0° (different AOI on request)
Substrate	Fused silica or BK7 or equivalent
Dimensions	as per customer request
Spatial dispersion	up to 100 nm / mm
Parallelism	< 3 arcmin
Surface Defects	5 / 3 × 0.1
Environmental Stability	Temperature – 100 ... + 150°C Humidity up to 99%

Application Linear Variable Filters



Longpass Filters



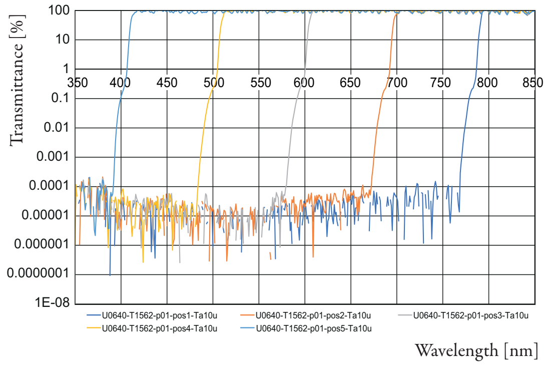
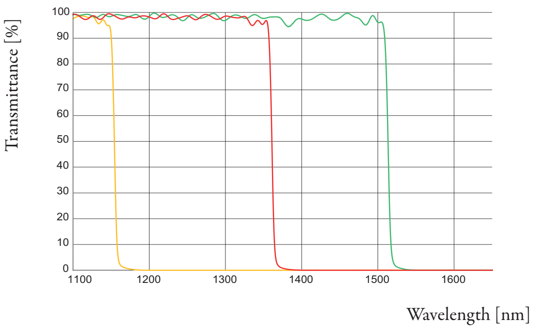


Fig.1: Linear variable longpass filter in the VIS, measured on different positions. The average transmission is > 97%.

Fig. 2: blocking performance measured on different positions on the filter. The absolute blocking is better than OD6 while the edge steepness 10%-90% is less than 3nm. The theoretical blocking of OD8 cannot be measured due to noise floor limitations.

Shortpass Filters



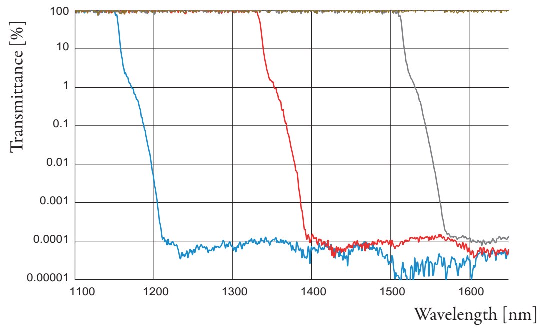
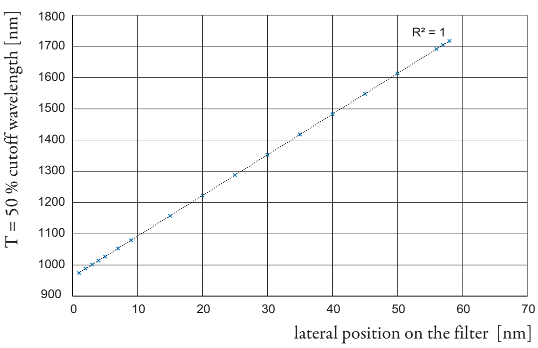


Fig. 3: Linear variable shortpass filter for the NIR, measured on different positions. The average transmission is > 97%.

Fig. 4: blocking curve measured on different positions on the filter. The absolute blocking is better than OD6 while the edge steepness 10%-90% is less than 5nm.



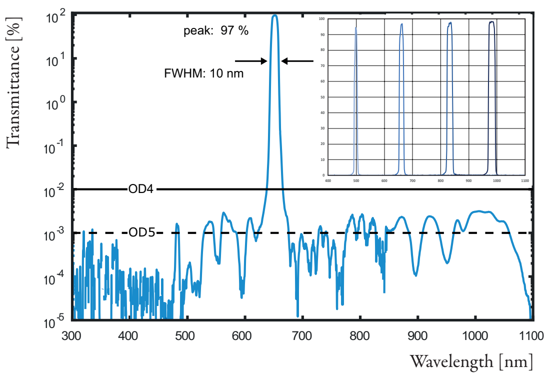
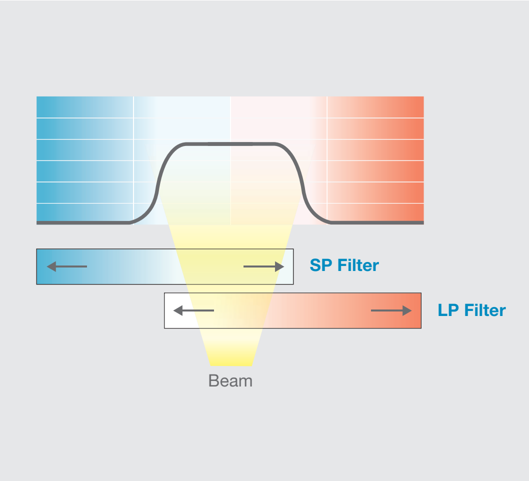


Fig. 5: NIR-shortpass measured at various lateral positions. It's noteworthy that the dependence of the cutoff wavelength on the measurement position follows a linear trend, with a coefficient of determination of R^2=1.

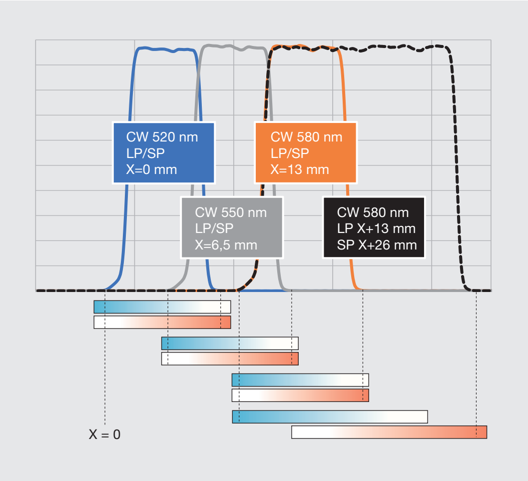
Fig.6: Linear variable bandpass for Si-sensors. The passband shifts from 360nm to 1000nm while blocking the full range 300nm – 1100nm with OD5avg.

Subject to technical change without notice

LVF based on the combination of LP-filter and SP-filter



Bandpass filter adjustment for tuning of different filter characteristics



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