Manufacturing of high performance optical filters for Multi- and Hyperspectral Imaging

EPIC TechWatch at W3+Fair Jena 2023

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Solutions for Multi- and Hyperspectral Imaging

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- Linear variable filters – Solution 3

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A global high-tech solutions provider of performance alloys, precision optics and advanced materials

- 100+ years of materials knowledge
- Publicly traded since 1972 NYSE (MTRN)
- In excess of $1 billion in sales
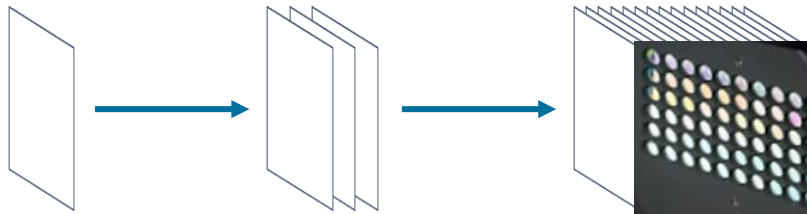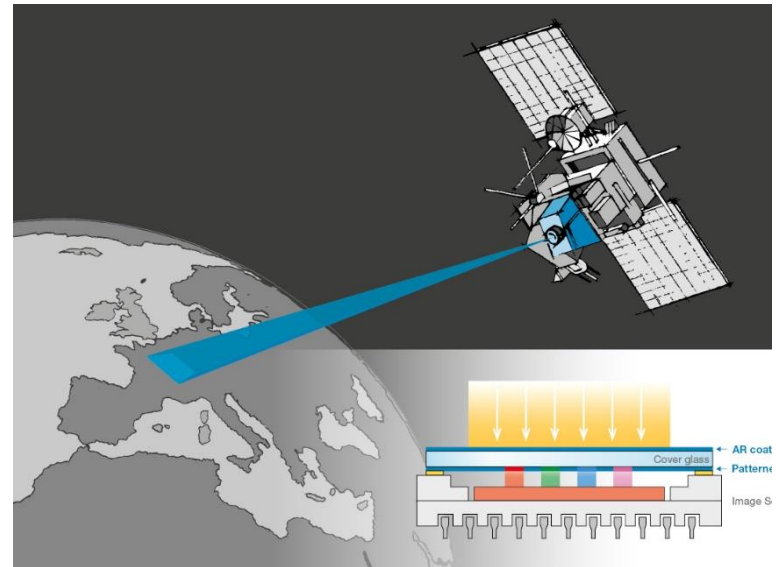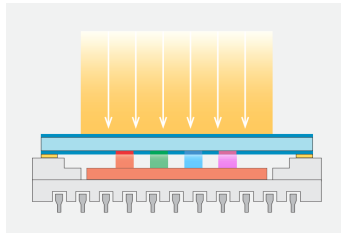
36
WORLDWIDE LOCATIONS

3,100
EMPLOYEES

61
COUNTRIES SERVED

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What is Multi- and Hyperspectral Imaging?

Capture of images with different spectral bands
- some (multispectral) or
- many (hyperspectral)

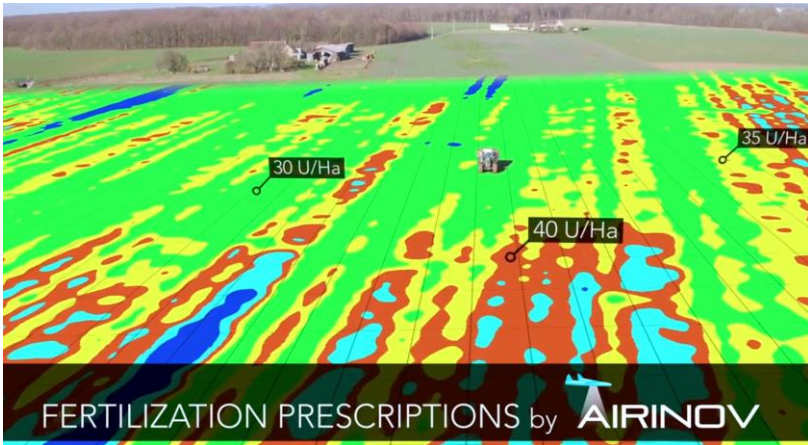one channel
(e.g. gray picture)

RGB image

Many different color channels, e.g. 10nm resolution in VIS range

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Applications of Multi- and Hyperspectral Imaging

Drone-based environmental monitoring
(air-born and space-born applications)

FERTILIZATION PRESCRIPTIONS by **AIRINOV**

Different spectral bands are used
to evaluate certain properties

| Band	Spectral range (μm)	Principal application
1	0.45-0.52	Coastal water mapping, soil-vegetation differentiation, deciduous-coniferous differentiation
2	0.52-0.6	Green reflectance by healthy vegetation
3	0.63-0.69	Chlorophyl absorption for plant species differentiation
4	0.76-0.90	Biomass surveys, water body delineation
5	1.55-1.72	Vegetation moisture measurement, snow-cloud differentiation
6	10.4-12.5	Plant heat stress measurement, other thermal mapping
7	2.08-2.35	Hydrothermal mapping

- Specifically targeted fertilization
- Smart agriculture

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Solution 1 – Individual Filters
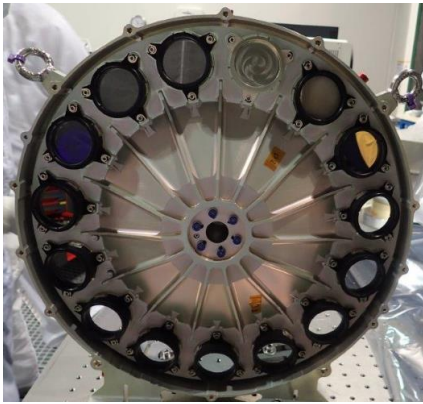
Airbus DS
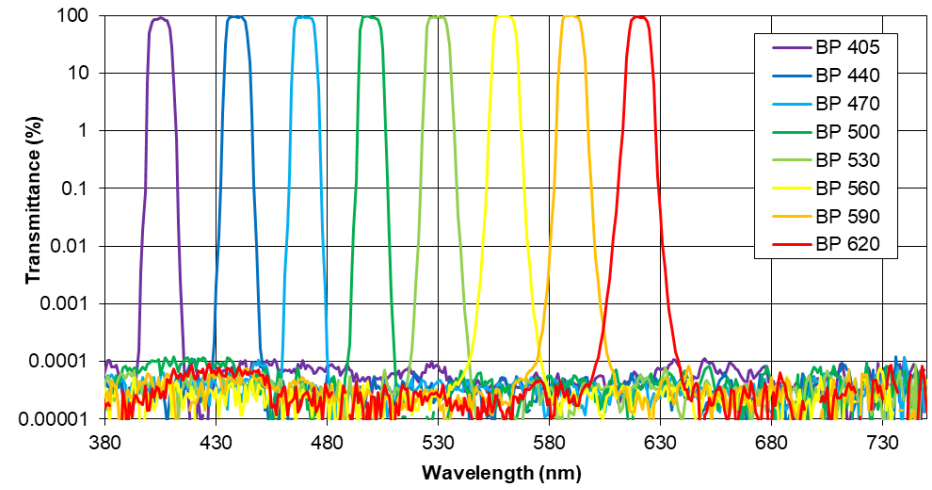
Filterset with several channels

Hyperspectral camera with > 50 channels
(courtesy of Cubert)

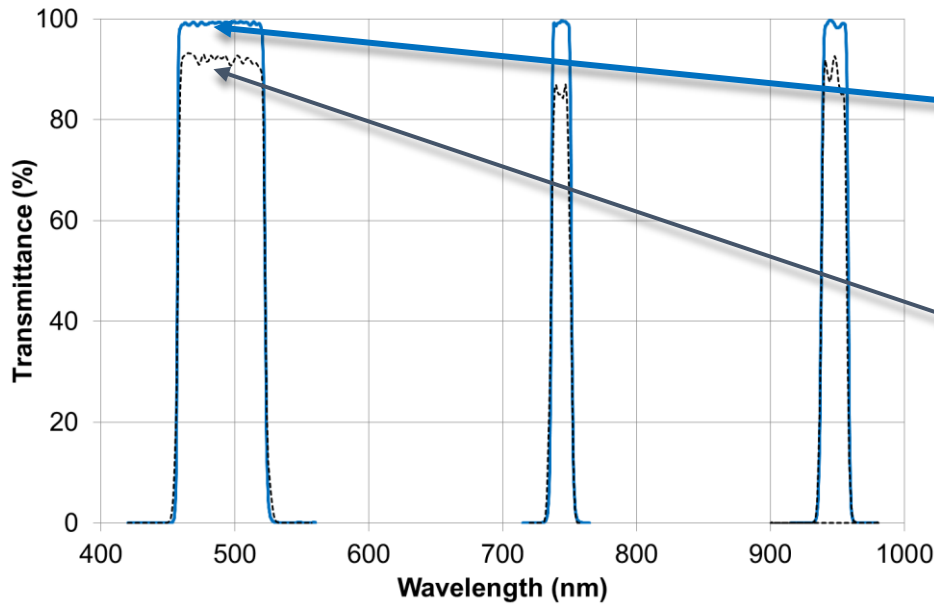wavelength scan

Spectral resolution: low-high
Speed: medium-high

Y W Wang et al., *Nanotheranostics* 1(4): 369-388, 2017

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Solution 1 – Individual Filters

PARMS dielectric filter
(utilized by Materion)

PARMS = Plasma Assisted Reactive
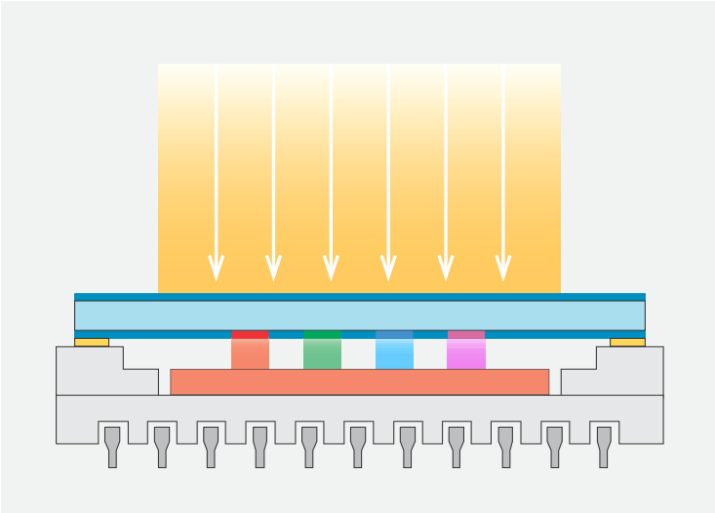Magnetron Sputtering

conventional optical filter

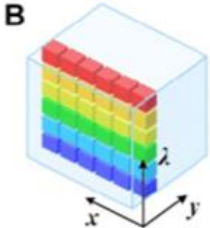Significantly improved SNR/image quality by using PARMS

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Solution 2 – Patterned Filter Arrays

Examples for high end applications

- Space-born and air-born imagers (drones, planes)
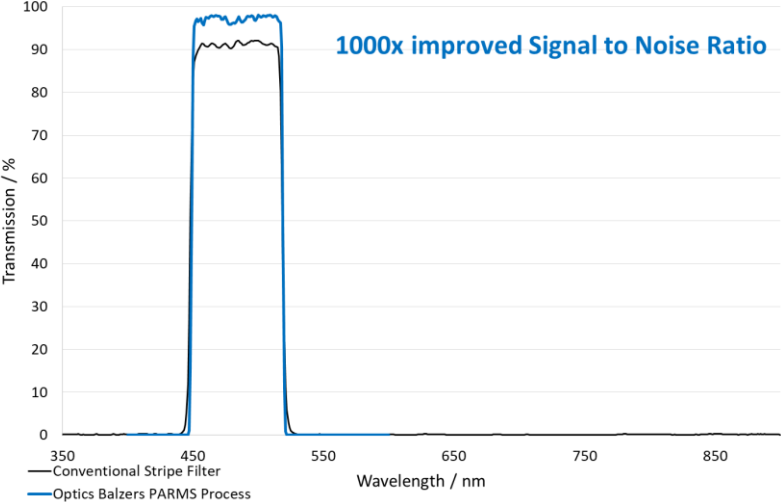- Agriculture
- Sorting applications, color measurements

http://www.teledynedalsa.com
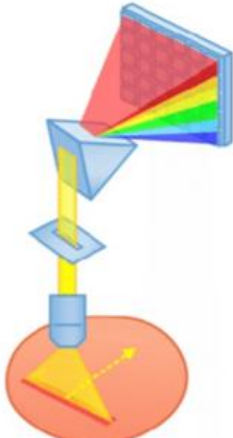
line scan
(push-broom)

Y W Wang et al., *Nanotheranostics* 1(4): 369-388, 2017

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Solution 2 – Patterned Filter Arrays

Multispectral Filter for Line Scan Cameras - Transmission

1000x improved Signal to Noise Ratio

Multispectral Filter for Line Scan Cameras - Blocking

1000x improved Signal to Noise Ratio
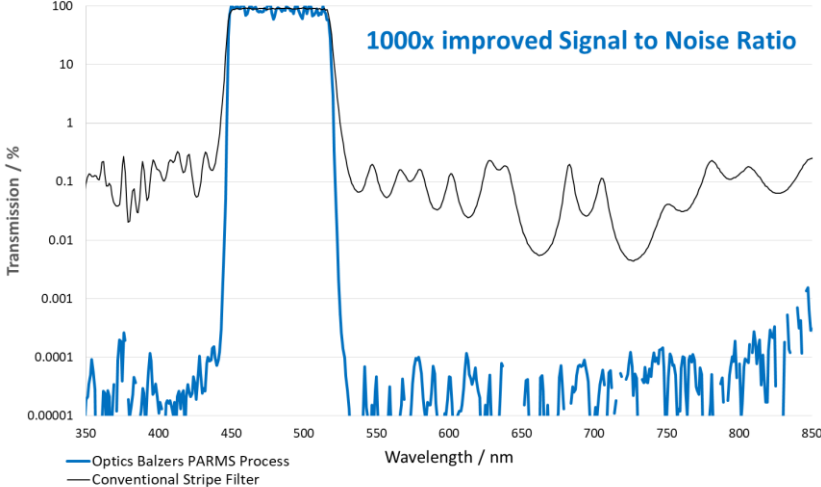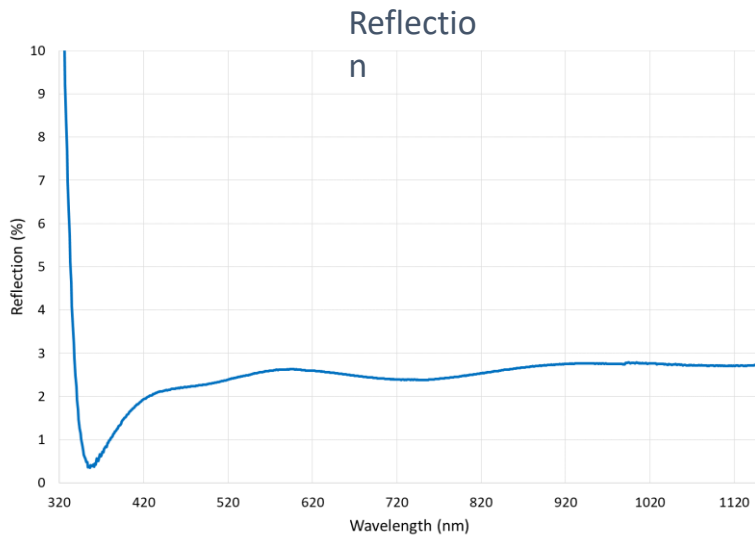
# Solution 2 – Patterned Filter Arrays

Prevention of cross-talk between channels by patterned black coatings CrBlack^{TM} or TiBlack^{TM}

- High absorption in the VIS to NIR range
- Low reflection in the VIS to NIR range
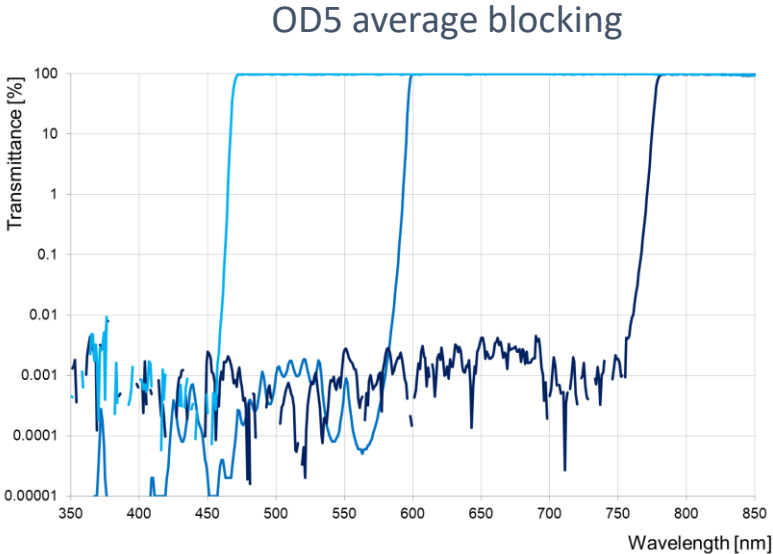- Excellent environmental stability

Reflection
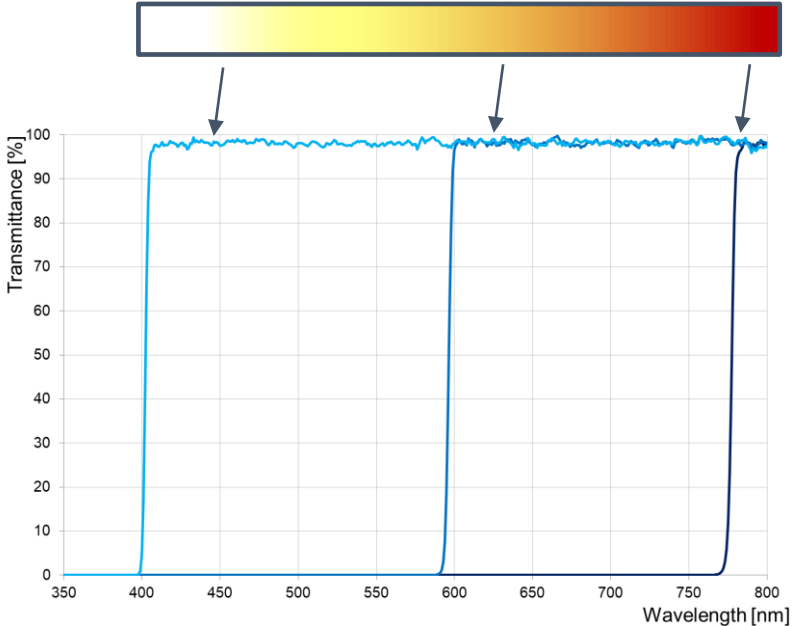
Transmission

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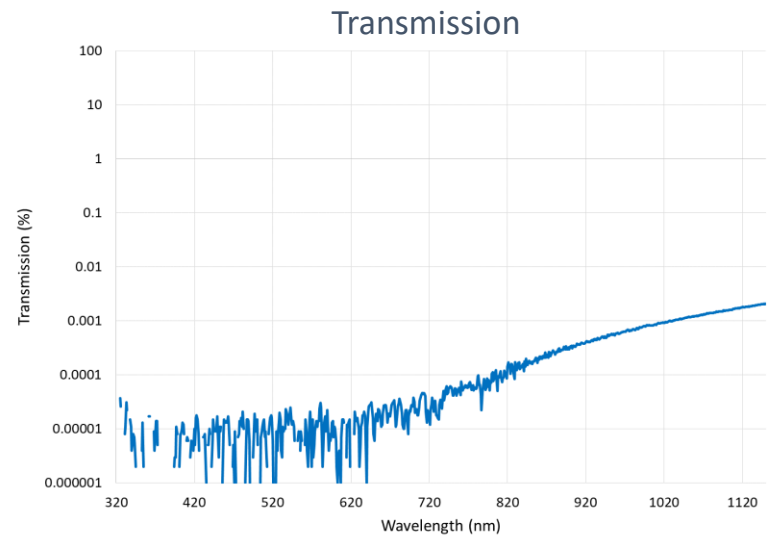
Solution 3 – Linear Variable Filters (LVF)

- One filter to rule them all
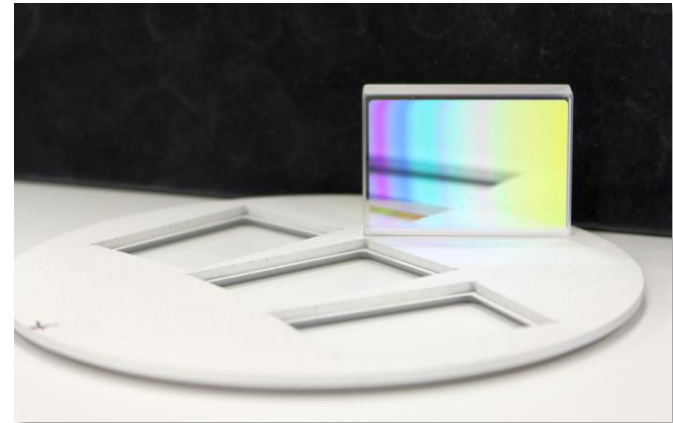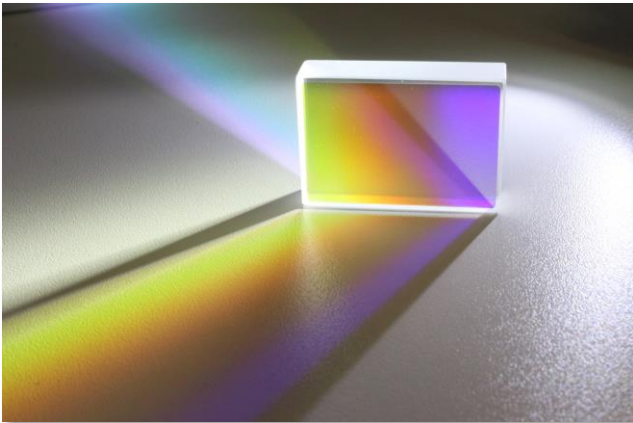
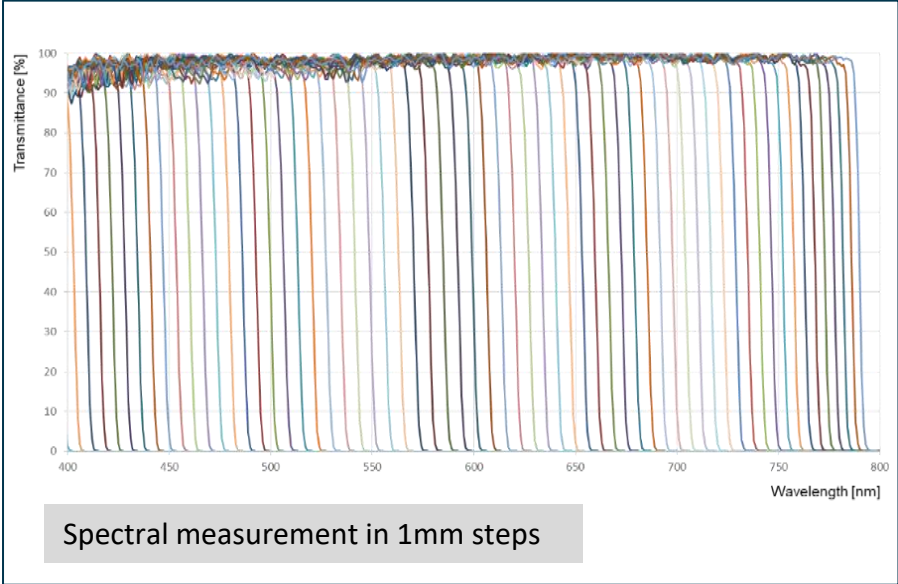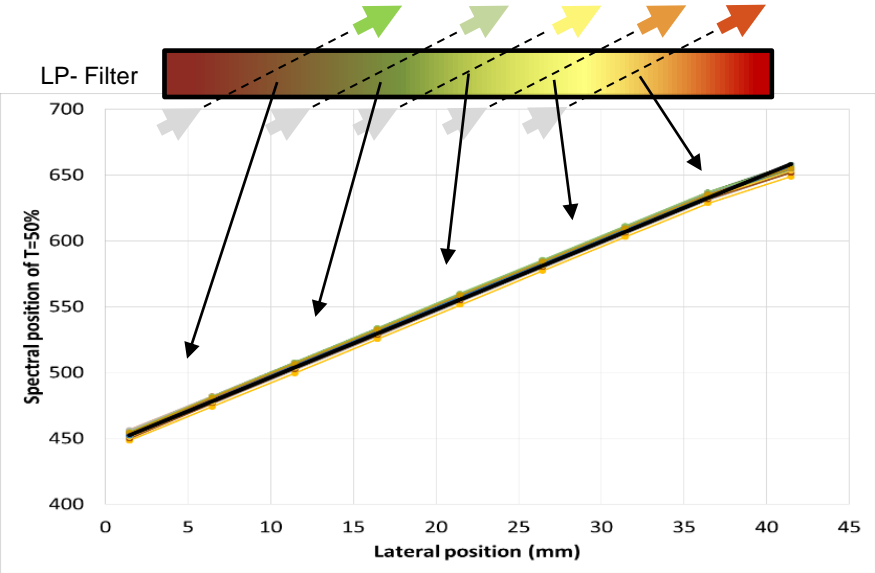# Solution 3 – Linear Variable Filters (LVF)

LVFs change their spectral characteristic depending on the position of illumination

OD5 average blocking

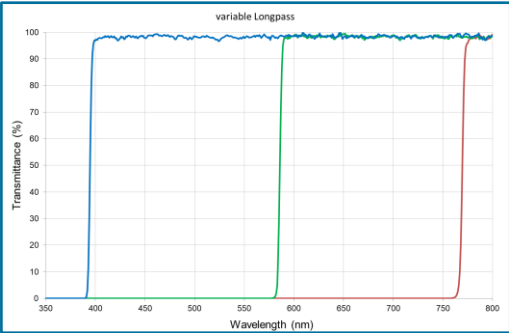# Solution 3 – Linear Variable Filters (LVF)

Detailed measurement / Qualification

Spectral measurement in 1mm steps

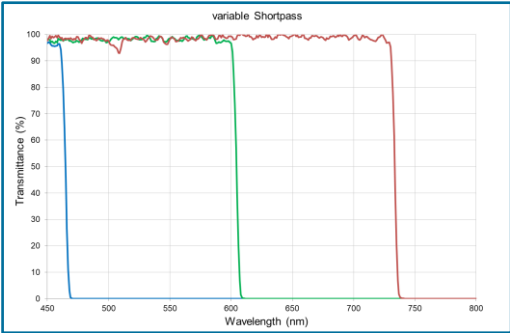Set-on Wavelength depends linearly on geometrical position on the filter

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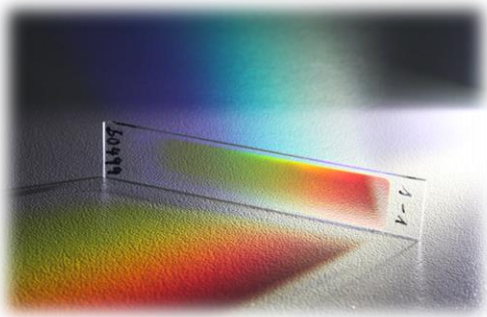# Solution 3 – Linear Variable Filters (LVF)
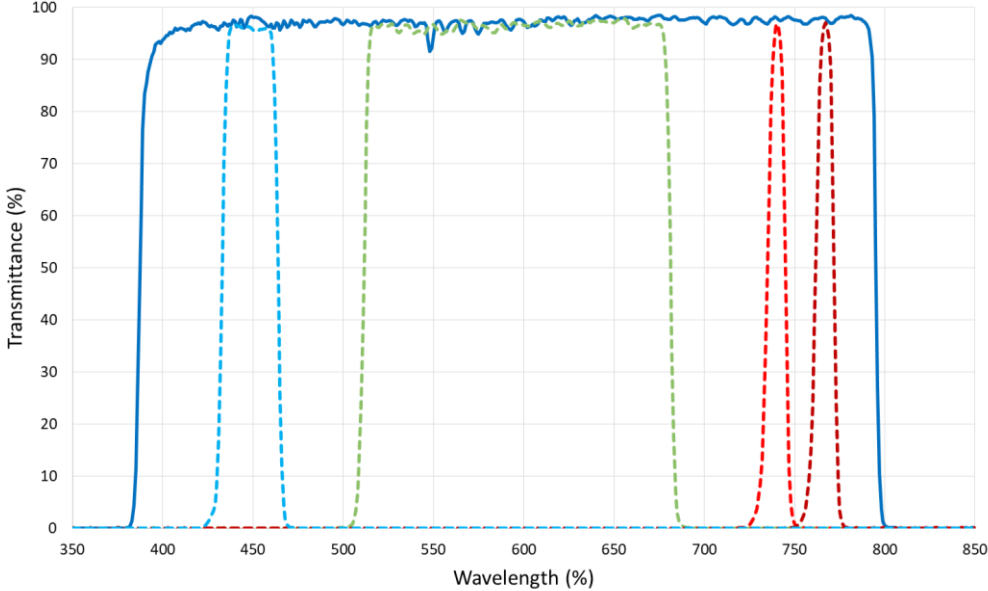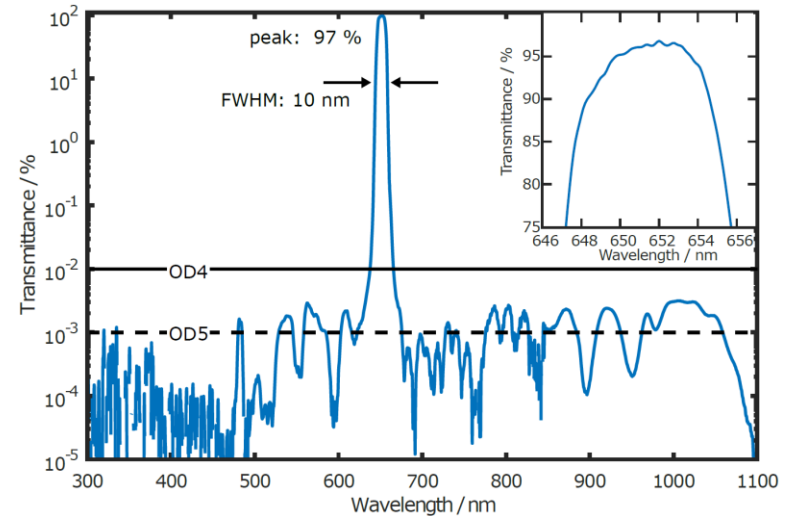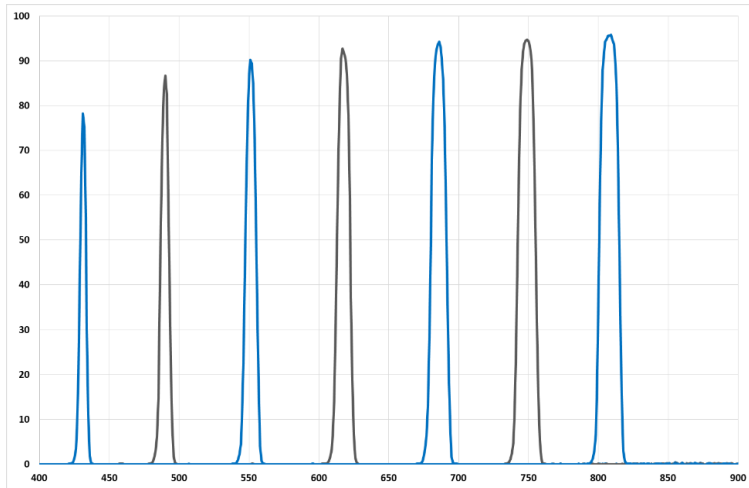
Long pass

Short pass

+
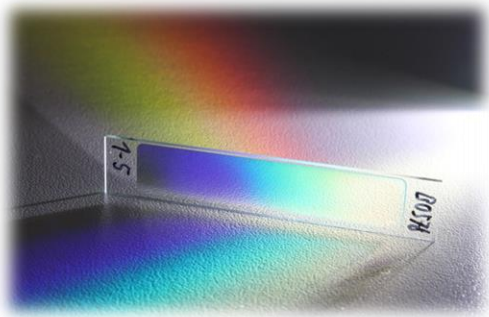
Solution 3 – Linear Variable Filters (LVF)

Change of bandpass center wavelength and width with local position on the filters

Solution 3 – Linear Variable Bandpass

Also, possible as bandpass, dichroic, …
Example: FWHM ~ 1.5% within 400-900nm
average OD5 blocking the full range of a Si-based sensor
T_{pass} > 97% @ 600nm

We are shaping the Century of the Photon

Thank you very much for your attention

To learn more about Materion and our capabilities, please feel free to contact me:

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