MULTISPECTRAL IMAGING
by SILIOS TECHNOLOGIES
About us
Montagne Sainte-Victoire
Industrial Zone of Rousset
(dedicated to semiconductor industry)
... Two Product Ranges

**MICRO-OPTIC** (2001)
SCIENTIFIC & INDUSTRIAL LASERS, ASTRONOMY & SPACE

A single Process: Realization of Multilevel Phase Profiles thanks to a cumulative etching process

**MULTISPECTRAL** (2009)
MULTISPECTRAL IMAGING

CMS series
Manufacturing Capacities

Area: 600 m²
Class: 100 down to 10 (FS209)
      5 down to 4 (ISO)
COLOR SHADES® Technology
Multispectral Filters
Technology

Pixelated Detector

Multispectral Filter

Transmission vs. Wavelength graphs
Any Geometries

Centimeter to micrometer scale Geometries

Geometries adapted to 1D or 2D CMOS
COLOR SHADES® Multispectral Filters

Multispectral Filters Design & Manufacturing

Technology for the VISIBLE & NIR Domain (between 400nm and 1000nm).

COLOR SHADES VIS-8
(Chip size : 9 x 2 mm²)
COLOR SHADES® Multispectral Filters

COLOR SHADES VIS-8
(Chip size : 9 x 2 mm²)

Tmax : 40% to 60%
FWHM : 20nm à 40nm
Max Spectral Range : 300nm (shiftable)
VIS-16 Spectral Response

Color Standard Chip for Microscopy.
Spectrometry & Multispectral Imaging
Sensors and CMS Cameras
1D Assembly: 8 Channel Spectrometer

COLOR SHADES® 1D Chip

COLOR SHADES® e-Board

1D CMOS (Melexis)
128 pixels – 66 µm
Sensor for Waste Sorting

COLOR SHADES CHIP 4
Number of bands: 4
Spectral ranges: 550 - 700 nm / 400 – 550 nm
Bandwidth (FWHM): 30 nm
Peak Transmission (%): 60%

4 quadran sensor
Si PIN PD 5980

2D

4 cm
Multispectral imaging: Custom Bayer Matrix (Pixelated Filter)

- Monochrome standard imager
  Resolution: N x M

- Standard RGB imager
  Resolution: N x M (after demosaicing)

SILIOS multispectral approach: filtering at the pixel scale

- 4 interleaved images
  Resolution: N/2 x M/2

- 9 interleaved images
  Resolution: N/3 x M/3

- 16 interleaved images
  Resolution: N/4 x M/4

Regular Color Imaging (RGB).

Multispectral Imaging.

Supply of a set of 4, 9 or 16 sub-images filtered @ different λ.
# Multispectral Imaging System Comparison

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<th>Space</th>
<th>Time</th>
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<td>Filter Wheel</td>
<td>Field of view =</td>
<td>Sequential</td>
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<tr>
<td>Sub-images</td>
<td>Field of view ≠</td>
<td>Synchronous</td>
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<tr>
<td>Pixelated Filter (custom Bayer Matrix)</td>
<td>Field of view =</td>
<td>Synchronous</td>
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Advantages:
- The microlens function is preserved (+50% photons).
- The filter is placed above the microlens avoiding high incidence angle onto the filter.

Drawback:
- Geometrical crosstalk (light from a filter N collected by a pixel M)

Solution: SILIOS developed a post-processing method that suppress the crosstalk.
Hybrid Assembly: CMS Series Multispectral Sensor

CMS multispectral Sensor (e2V Ruby based)
CMS Series (Multispectral Cameras)

1.3 Mpx
USB3.0 or GigE

COLOR SHADES Lab (SDK)
+ DLL for:
  ✓ Hypercube extraction
  ✓ Crosstalk correction
Measured transmission curves of the filter.
Quantum Efficiency of the multispectral sensor.
Compensated Crosstalk Efficiency of the multispectral sensor.
Multispectral Image Management

Raw multispectral image
Multispectral Image Management

Raw multispectral image
Multispectral Image Management

Raw multispectral image
Multispectral Image Management

Raw multispectral image

Panchromatic
Multispectral Image Management

Spectrum extraction

Chlorophyll red-edge

Chlorophyll signature

green 550nm
Infra-red > 750nm
red 650nm
The Chlorophyll-rich objects of this scene are highlighted in Red Color.

Chemical Image
CMS Series Image Samples

Raw images (contains the 8 spectral channels + 1 additional B&W channel)
Colored images (RGB image coming from the combination of the 8 spectral channels + the B&W channel)
Applications
PRECISION FARMING

Drone Field Mapping
COSMETICS
Personalized Skin care and Make-up
NEW SPACE
Earth Observation

Nano-/Micro-Satellites
MEDICAL
Dermatology / Endoscopy / ...
DEFENSE
Decamouflage
Your Custom Multispectral Camera

Have you made the proof of concept with our off-the-shelf CMS cameras for your application?

Need for a specific range?
Specific band centering?
A specific image resolution?
A specific image sensor?
...

We’ll develop YOUR custom multispectral camera for YOUR specific application!
Already worked on a Large Diversity of Sensors

- CMS
  - CMOS e2V/teledyne RUBY 1.3 Mpx
  - e2V/teledyne ONYX 2.0 Mpx
- CMS
  - ViiMagic 2.0 Mpx
- CMS
  - CMOSIS CMV4000 4.0 Mpx
  - High dynamic sensors > 120 dB VGA
  - SWIR sensors
- CMS4
  - Ultra fast sensors 1.0 Mpx

CMS 2016 to 2019
Reminder: Main Advantages

Custom Bayer Matrices approach:
- Small footprint sensors.
- Light sensors.
- Robust sensors (not sensitive to vibrations).

COLOR SHADES® filters:
- Large numerical aperture acceptance.
- High integrated transmission (higher sensitivity).

Hybrid assembly approach:
- Versatile: compatible with almost any sensor and multispectral configuration.
- Economically viable from low to medium volume production.
- The hybrid architecture allows preserving the microlens function (higher sensitivity).
News
SILIOS on TV !

SILIOS under the spotlight (on French TV)
CMS4 Series (Coming Soon! Q1 2019)

4.0 Mpx
USB3.0 or GigE

COLOR SHADES Lab (SDK)
+ DLL for:
  ✓ Hypercube extraction
  ✓ Crosstalk correction
Thank you for your attention