Hyperspectral imaging
data correction and standardization,
mobile applications

HSI area scan sensors

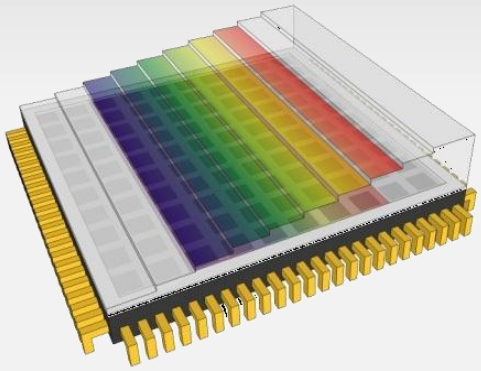
imec

HSI sensors

HSI sensor types from imec (used in XIMEA cameras)

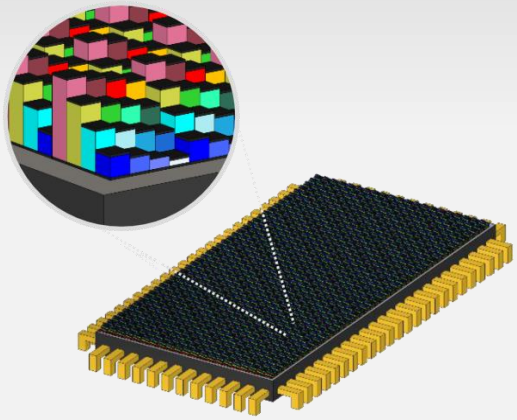
filter layouts

line scan



'wedge' design
100 bands: ~ 600 – 975 nm
150 bands: ~ 470 – 900 nm (new)

Snapshot Mosaic



'per-pixel' design
4x4: ~ 470 – 630 nm
5x5: ~ 600 – 975 nm

HSI sensor types from imec (used in XIMEA cameras)

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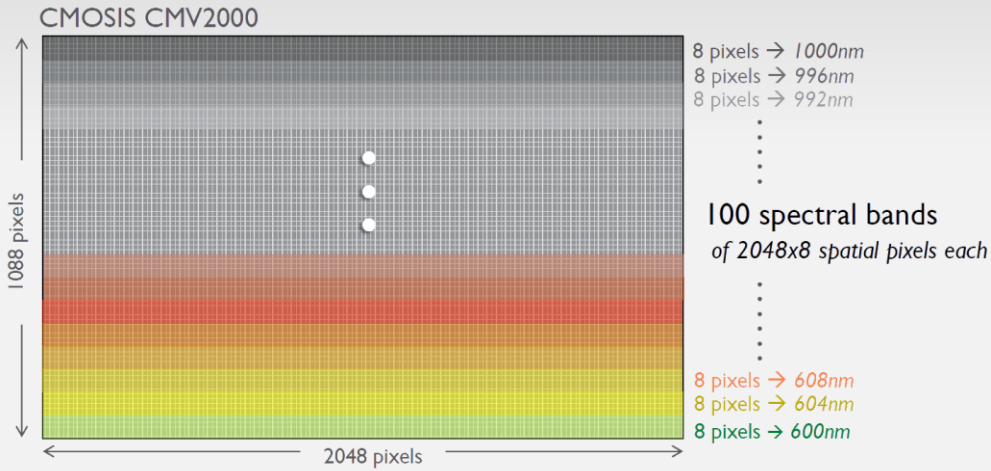

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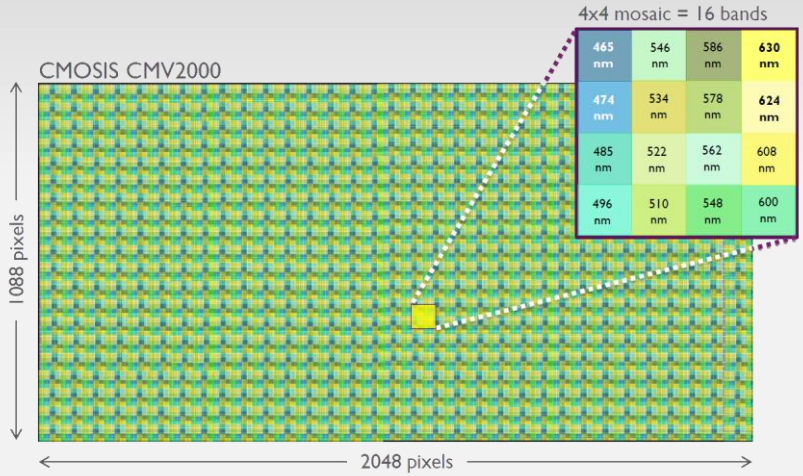
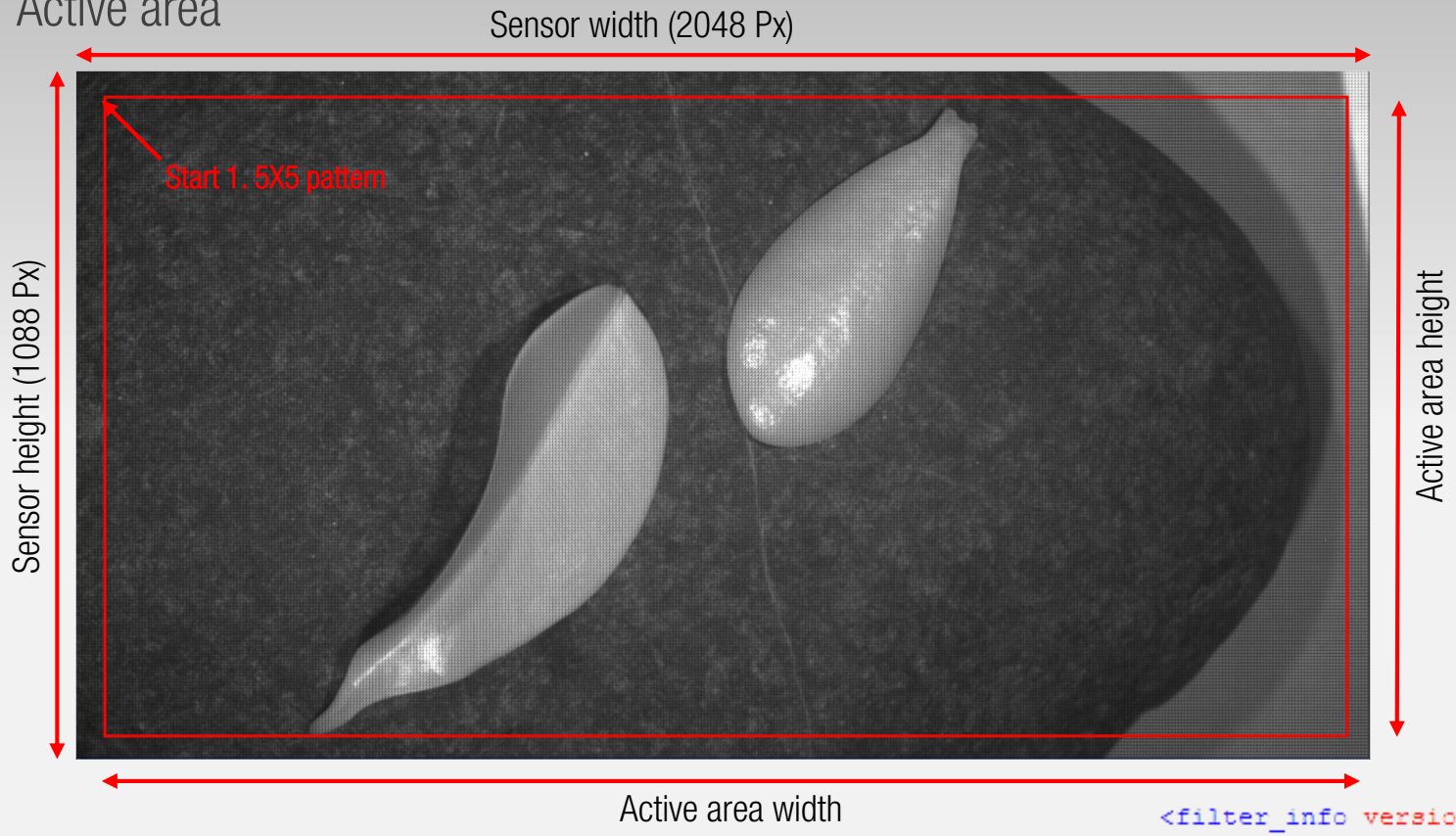


'per-pixel' design
4x4: ~ 470 – 630 nm
5x5: ~ 600 – 975 nm

RAW image interpretation (calibration files)

Snapshot mosaic 5X5-NIR, 675-975nm

Active area

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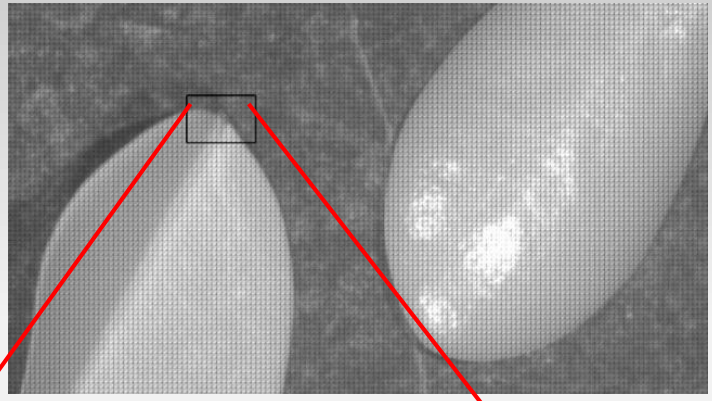
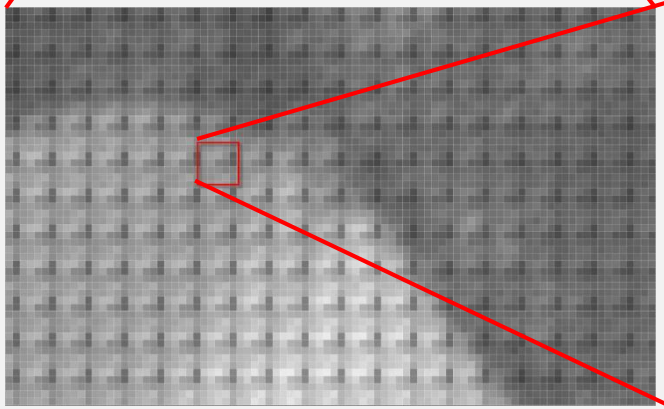
RAW image interpretation / snapshot mosaic

2 leaves on a stone

Snapshot mosaic 5X5-NIR, 675-975nm

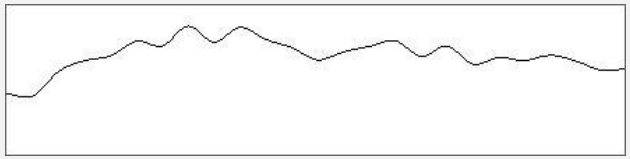




Single 5X5 pattern, wavelength peaks [nm]

900	909	892	882	683
809	821	797	784	693
759	772	746	732	708
943	949	935	927	975
861	873	852	840	955

Spectrum (Raw-values)



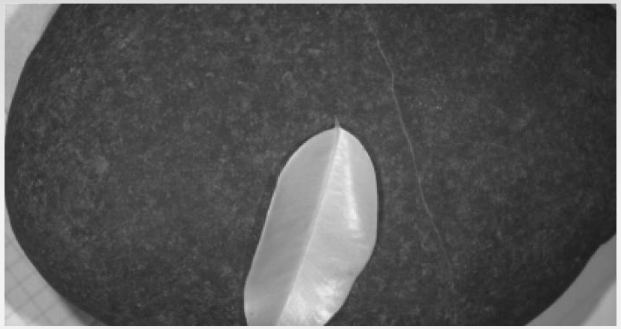
675 nm 975 nm

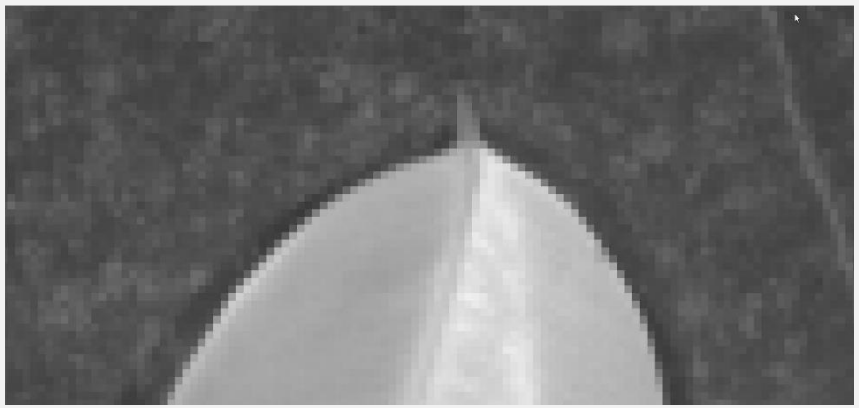
Demosaicing / interpolation / snapshot mosaic

The spatial resolution in case of a snapshot mosaic sensor is about

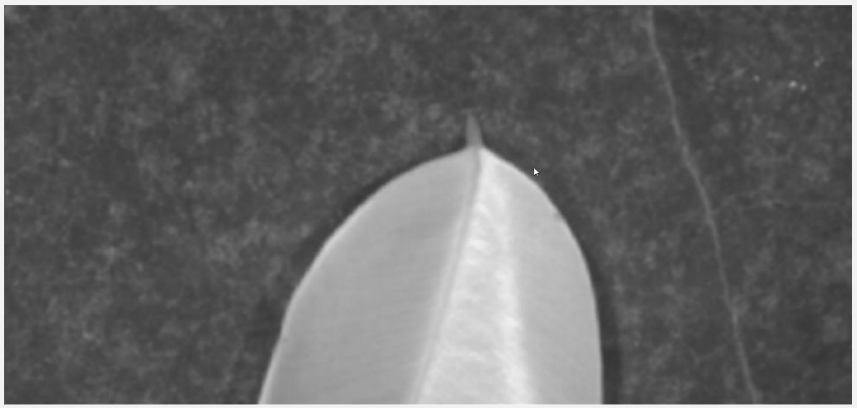
SM 5X5: <= 409 * 216 px SM 4X4: <= 512 * 272 px

By Interploation / demosaicing the native resolution of the active region can be calculated:





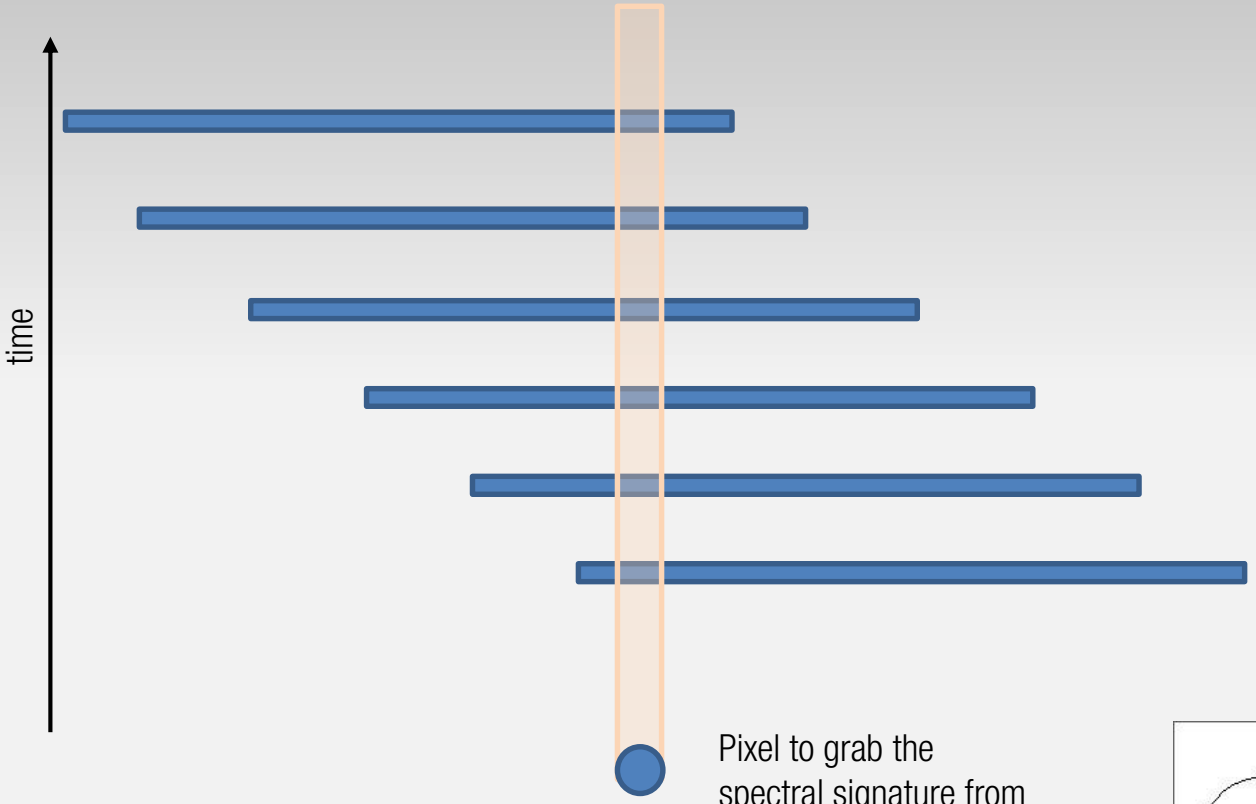
spatial resolution

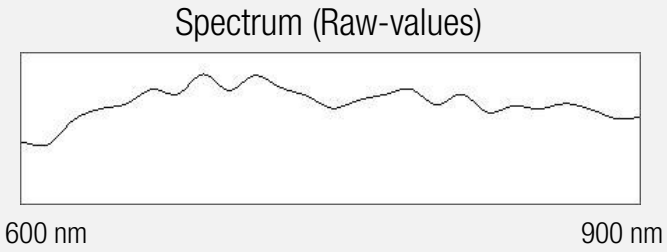


interpolated resolution

RAW image aggregation / line scan

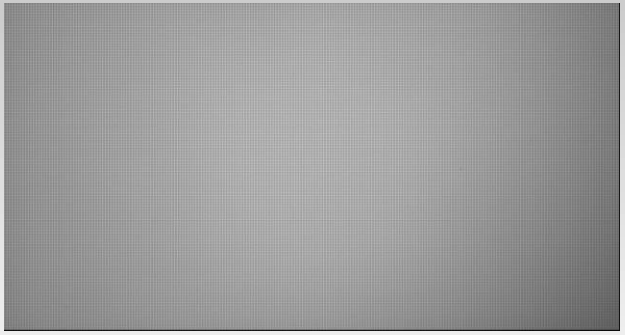
Sensor or object has to moved. The spectral info for one position has to be collected:





Data correction – vignetting / snapshot mosaic

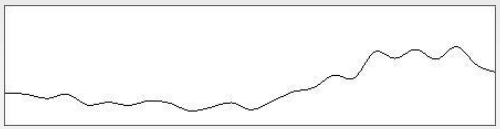
When using standard VIS-NIR lenses, a significant “vignetting” may occur:



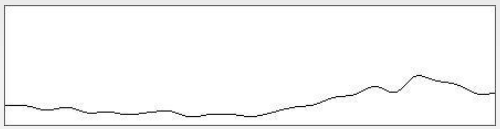
f=2.8 (recommended aperture from imec)

Snapshot mosaic 5X5-NIR, 675-975nm,
Edmund Optics 35mm VIS-NIR lens
Halogen lighting

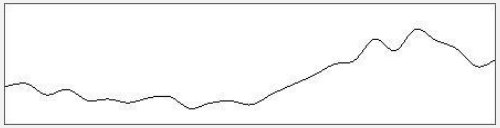
The “vignetting” has also an impact on the spectral curves:



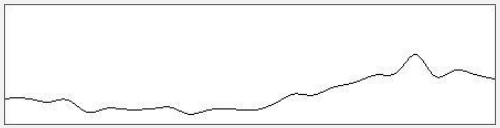
upper left corner



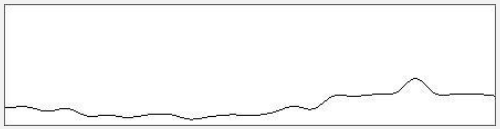
upper right corner



center



lower left corner

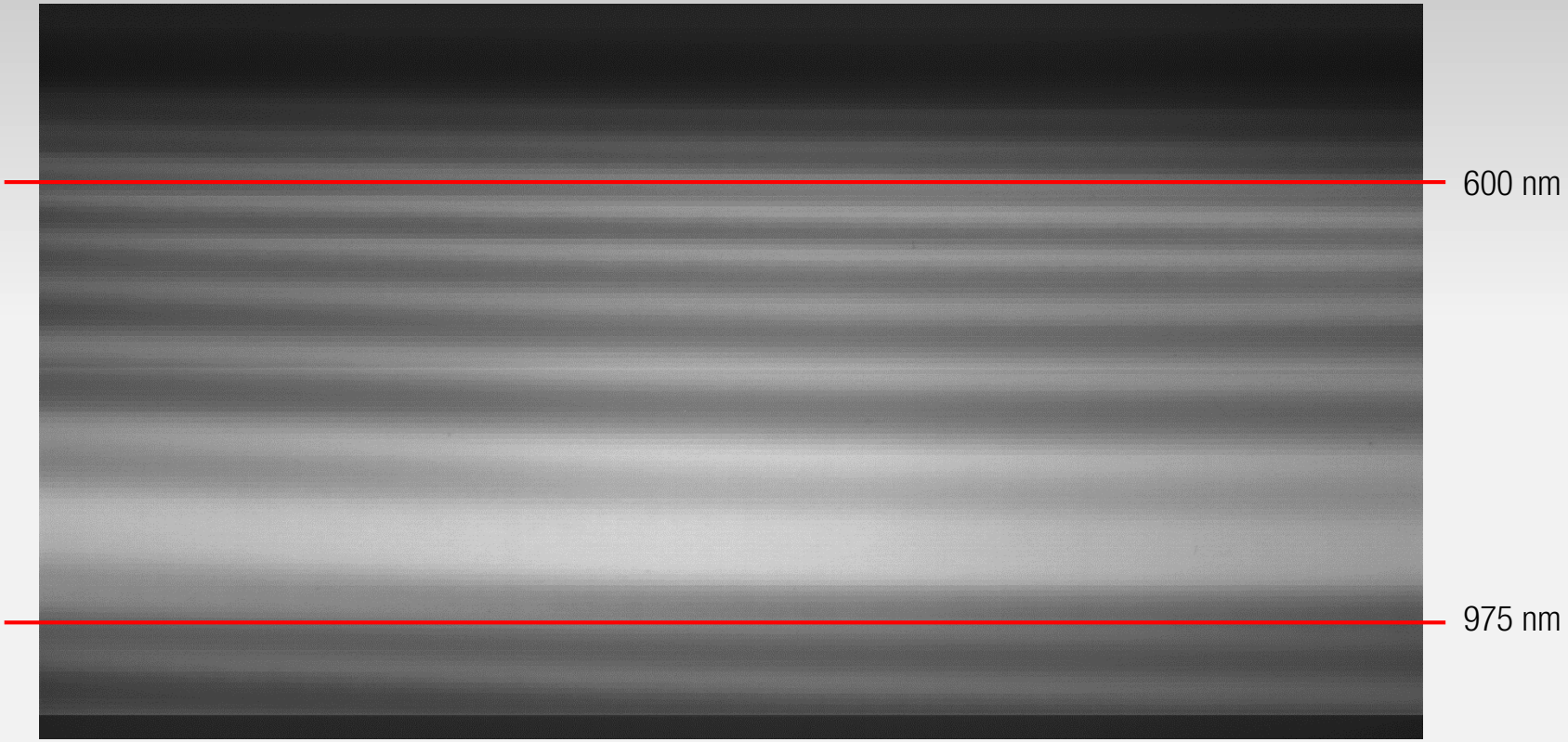


lower right corner

It is recommended to a implement a white image / fixed pattern image correction for each band

Data correction – vignetting / line scan

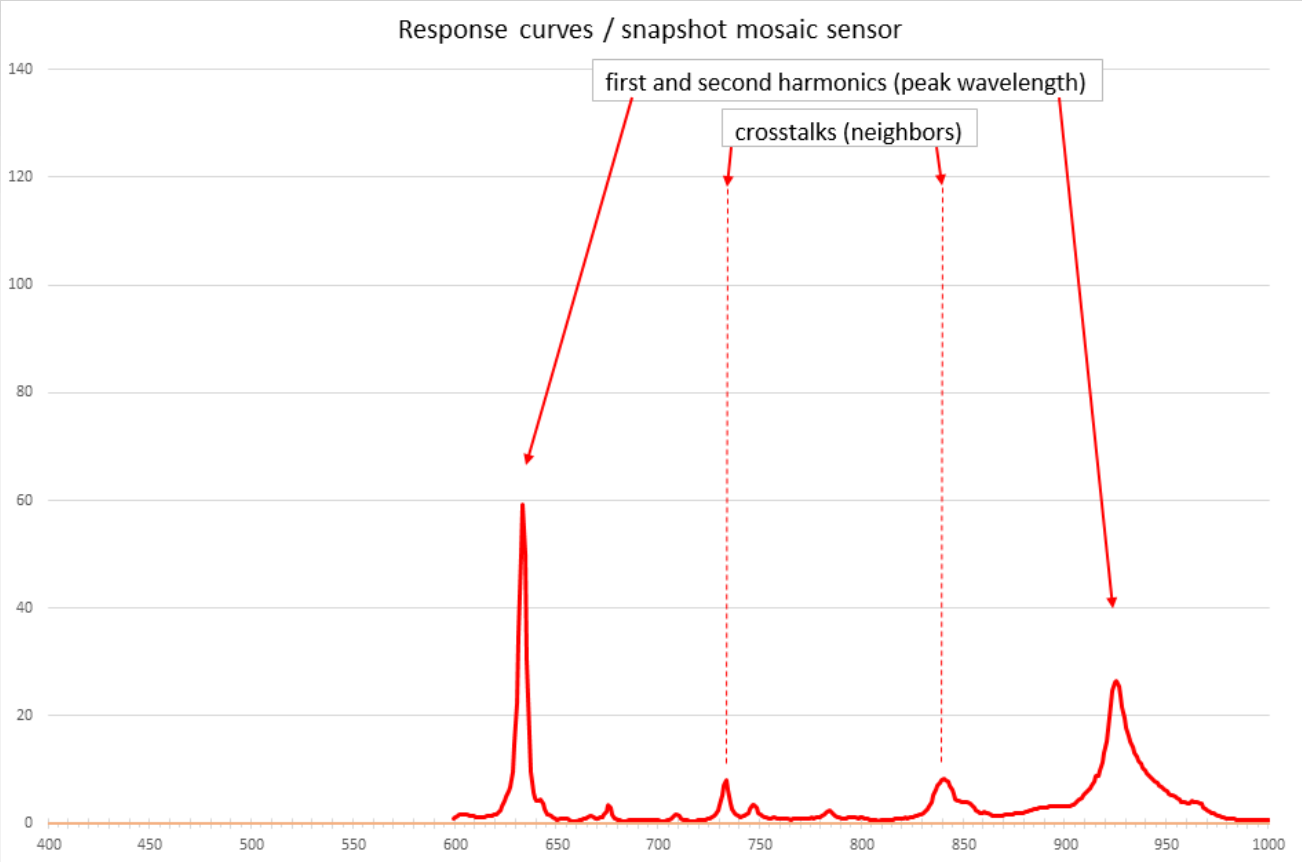
A significant “vignetting” may occur, depending on the lens and angle of the light:



It is recommended to a implement a white image / fixed pattern image correction for each band

Data – spectral correction / snapshot mosaic

The response curves have crosstalks with neighbors. Several curves have two peak wavelength (can be eliminated with long or short pass filters).



Data – spectral correction / snapshot mosaic

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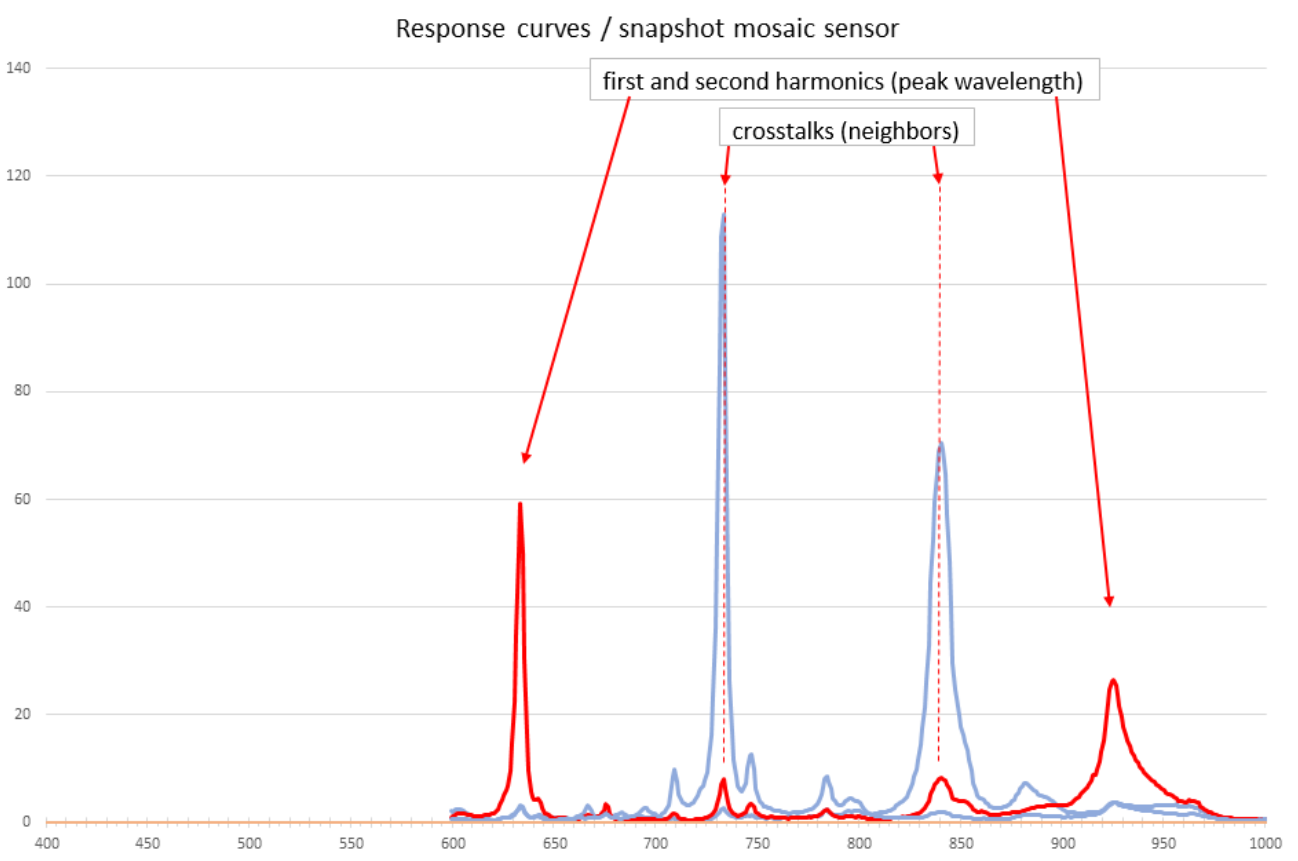
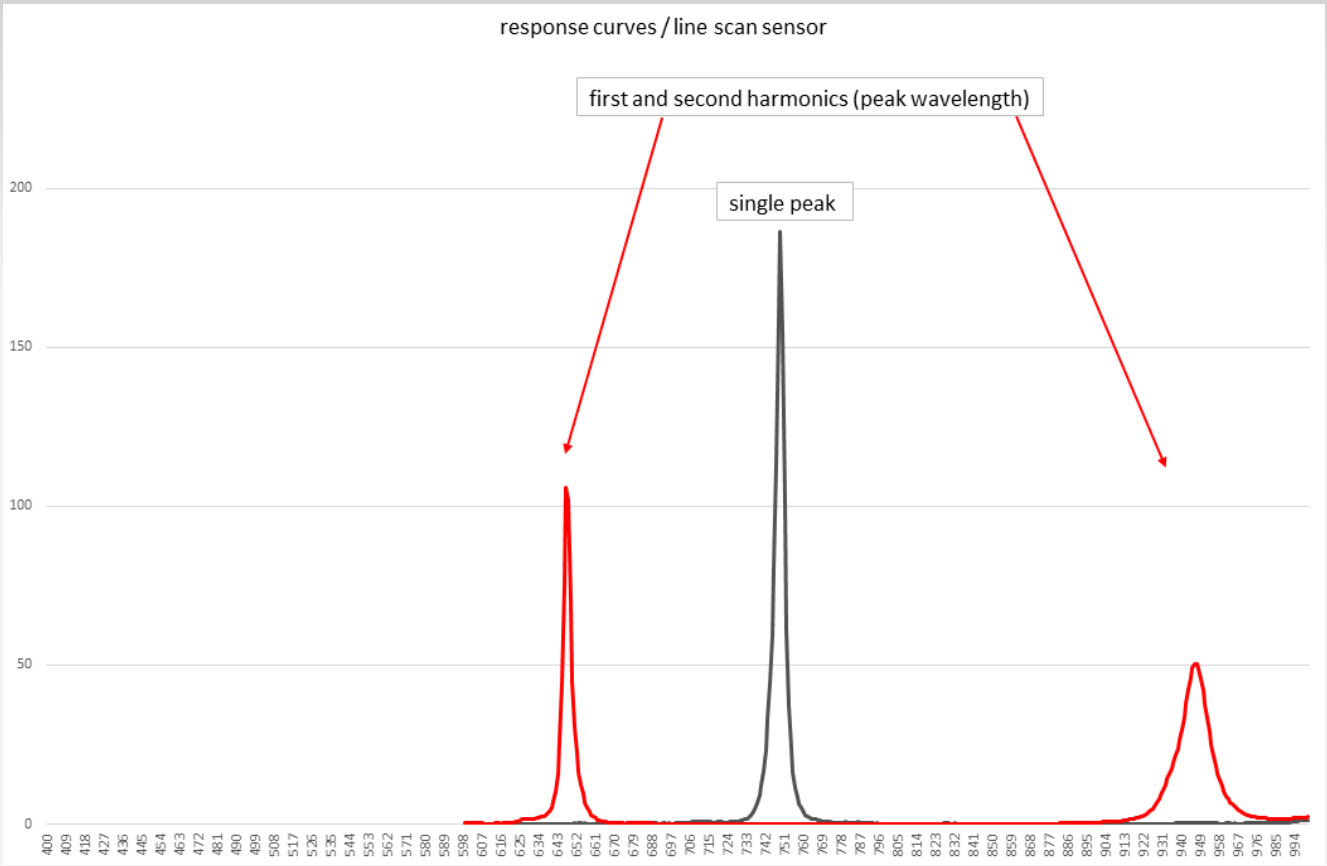


Position of the crosstalks are at the peak wavelength of neighbors.
This effect can be corrected by a correction matrix.

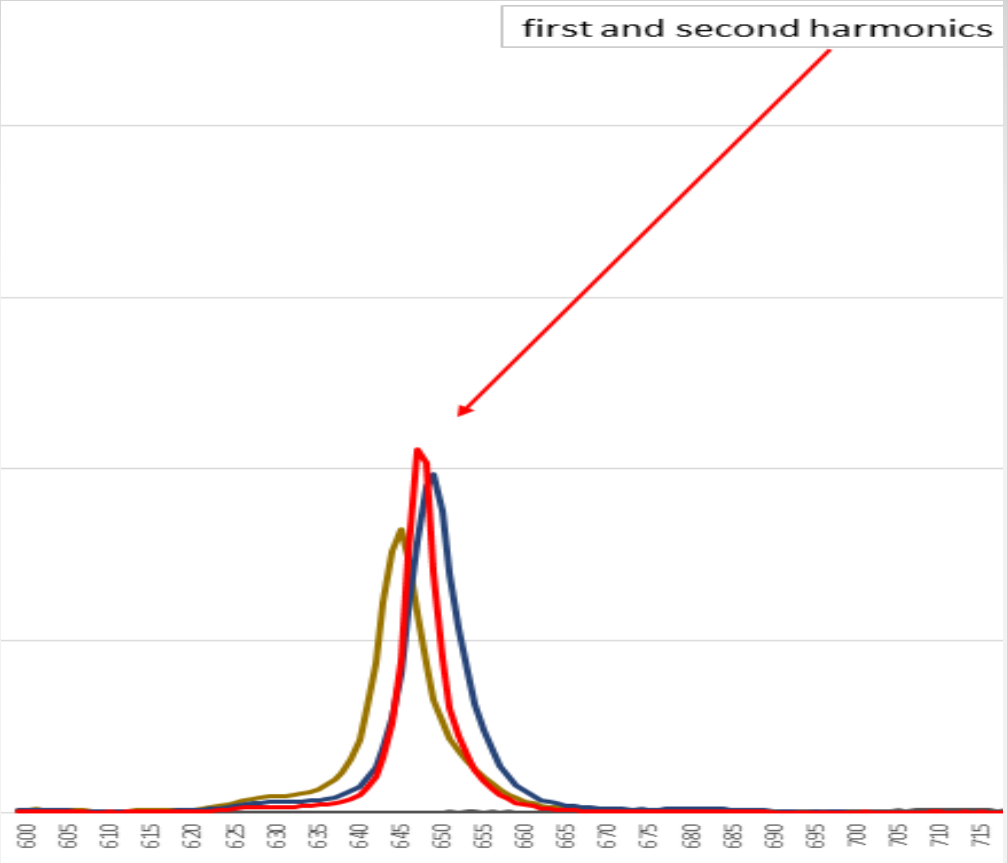
Data – spectral correction / line scan mosaic

Some response curves have two peak wavelength (cannot be eliminated with long or short pass filters).



Data – spectral correction / line scan mosaic

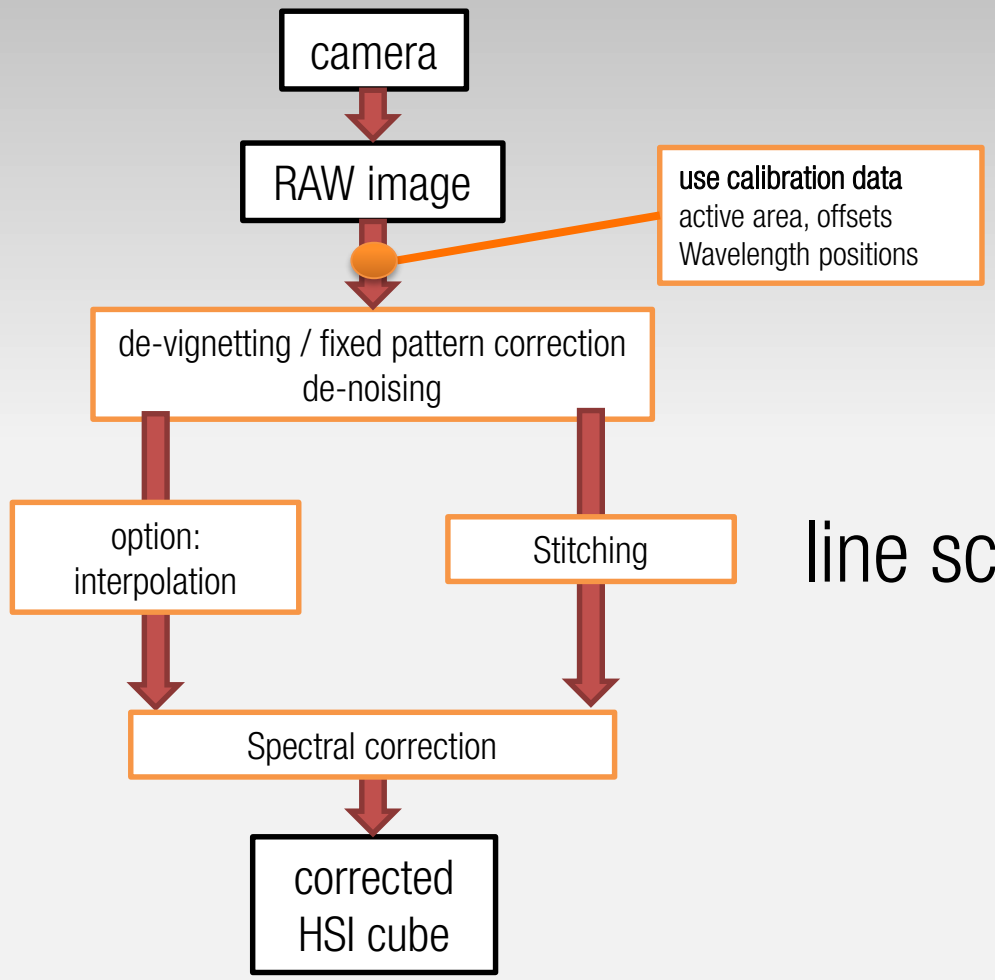
Some response curves have two peak wavelength (cannot be eliminated with long or short pass filters).



The position of the second harmonic (peak wavelength) is not the peak wavelength of another band.
This effect can be corrected by a correction matrix.

Data correction steps

simplified



Snapshot mosaic

line scan

Standardization

The standad EMVA 1288 is to be expanded in order to describe hyperspectral imaging cameras.
The first meeting took place on 03/03/2016 at Imec (Leuven, Belgium).

Mobile applications

For the operation of cameras a computers is needed to

- control the camera(s)
- grab images
- data compression if needed
- send and store data
- process and analyze the data

For hyperspectral imaging the computer has to be powerful.

Mobile applications

XIMEA is developing a very compact (HSI) imaging and recording unit for mobile applications, e.g. installable in payload compartment of drones with

- massively parallel computational resources onboard
- storage on fast SD (UHS-II SDHC/SDXC) or M.2 PCIe x 4 SSD (1000-1200 MB/s)
- integrated IMU 9-axis
- interface to a drone control unit
- interface to connect GPS / wireless connection

This system is able to handle several cameras at once, e.g.

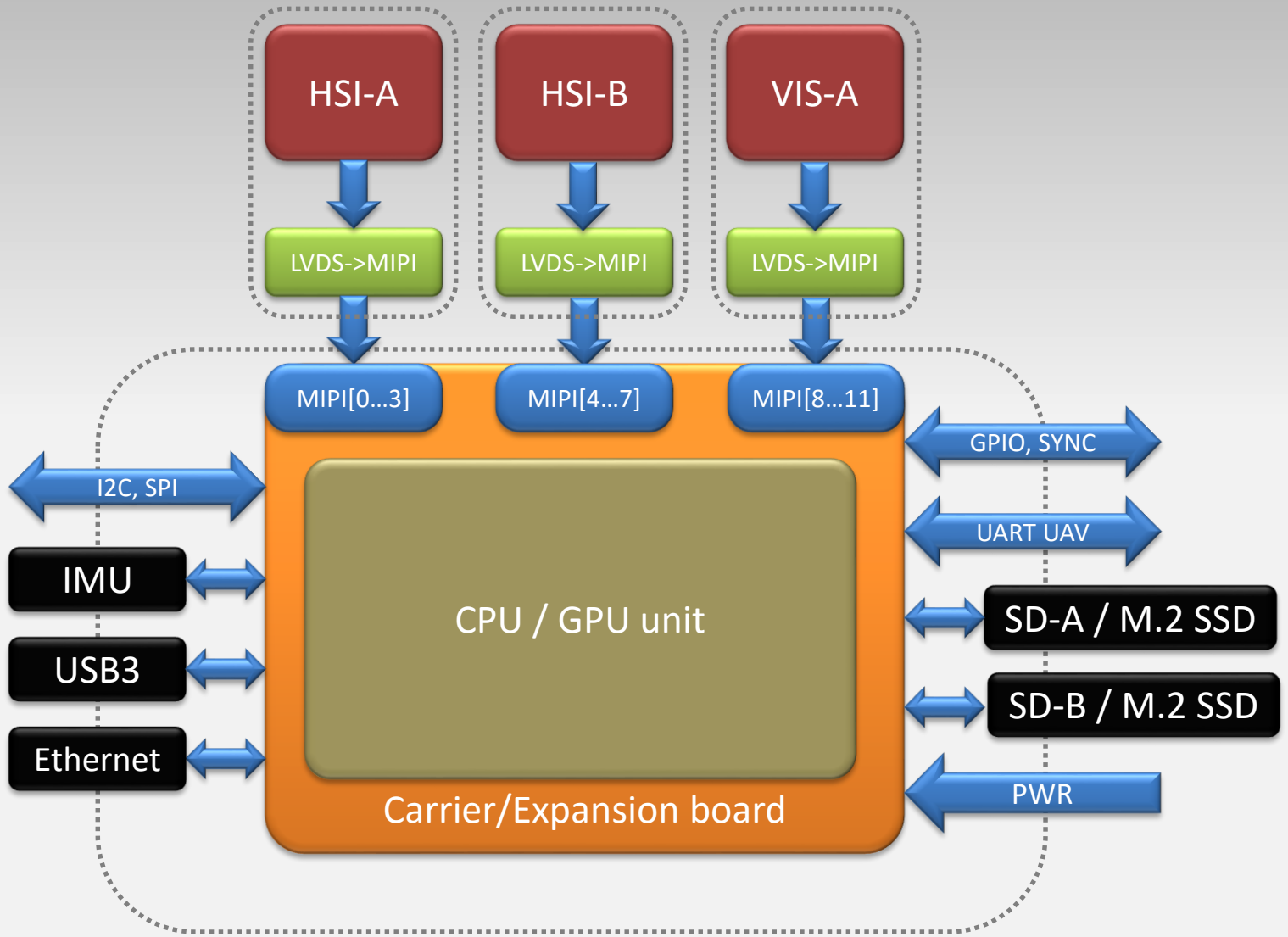
- 1 or 2 HSI cameras (looking downwards)
- visible light sensor (looking downwards)
- additional HSI-camera or spectrometer for ambient light measurement

Mobile applications

The system is disigned to (e.g.)

- create the corrected hyperspectral imaging cube for the connected xiSpec cameras in realtime
- match spectral signatures against pre-learned signatures
- perform a data self clustering / principal component analyzis (PCA)
- check whether differences against expected results occurs
- perform a multi-pass flight (other directions, different flight altitude for detailed data)
- optional data reduction (store only not expected info, e.g. possible plant diseases for a detailed postprocessing)

HW block diagram and interfaces



Thank you for your attention

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