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**Enhancing Earth Observation: Monolithic & Hybrid Integration of
Multi/Hyperspectral Filters for New Space**

Space Tech Expo Bremen – 20/11/2024

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IMEC: INDEPENDENT R&D HUB

SEMICONDUCTOR SCALING AND NANOELECTRONICS

FOUNDED 1984, HQ IN LEUVEN, BELGIUM

>5500 PEOPLE OF >95 NATIONALITIES

>600 PARTNERS

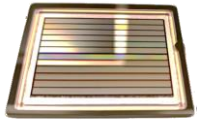
935 M€ REVENUE IN 2023

(70% FROM INDUSTRY)

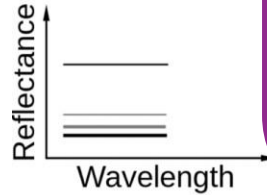
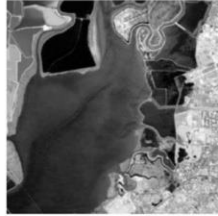
FAB INVESTMENT >3.5 B€



Spectral imaging from small satellites



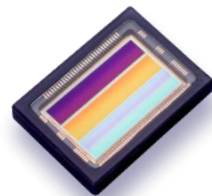
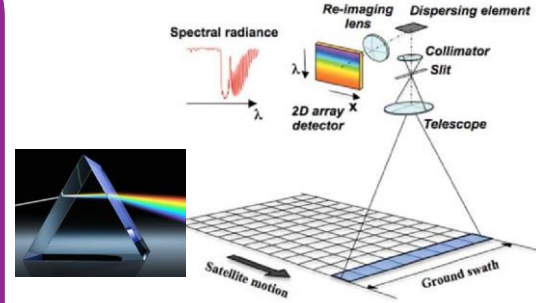
Single Band



— Sandy Soil — Pinewood
— Grassland — Silty Water

Discriminate subtle colour differences
to extract **a wealth of information**

Miniaturization via integration on chip (monolithic and hybrid)



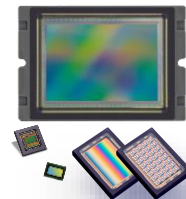
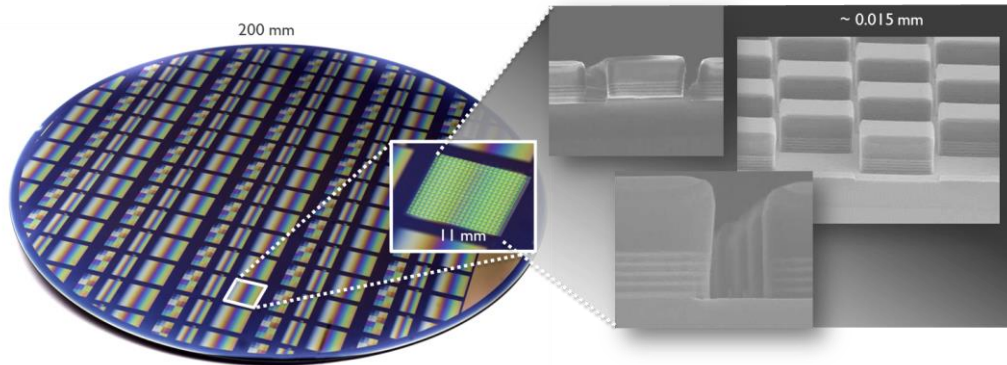
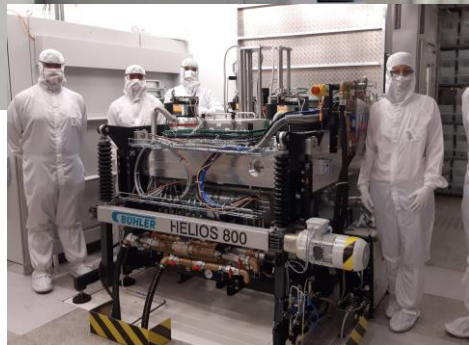
On chip spectral imaging

On chip spectral imaging

On-chip spectral imaging

Wafer level patterned spectral filters

- Scalable CMOS process
- Snapshot, video & scanning
- Miniaturized and robust
- Easy to integrate @ application level
- VIS, NIR, SWIR and beyond



Added value for earth observation from small sats



imecs deposition and patterning technique

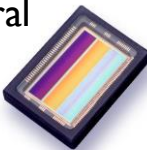
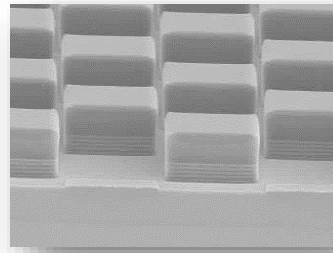
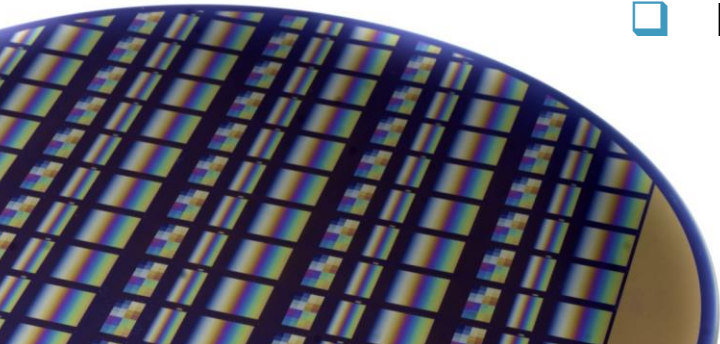
- ☐ Clean
- ☐ At wafer level
- ☐ Accurate
- ☐ No transitions
- ☐ Scalable

Filter characteristics

- ☐ Thin film filters
- ☐ Robust integration
- ☐ Many bands
- ☐ Many lines per band
- ☐ Filter per pixel
- ☐ Flexible geometries

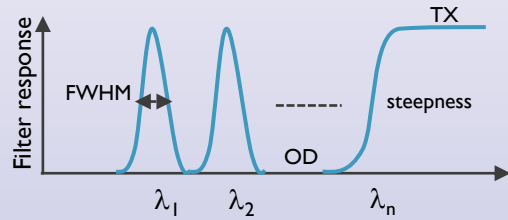
Added value for EO

- ☐ Low SWAP, compact payloads
- ☐ Harsh environments
- ☐ Multi and hyperspectral imaging
- ☐ Large format through staggering
- ☐ TDI for improved SNR
- ☐ Spectral snapshot/video imaging
- ☐ Innovative imaging modes:
 - ☐ Computational imaging
 - ☐ High res / low res spectral imaging mode



On chip spectral imagers for new space

1. Filter stack



- Lorentzian Fabry-Perot
- Gaussian filter
- Bandpass
- Edge-pass
- Notch
- Multi-harmonic
- ...



2. Pattern and layout

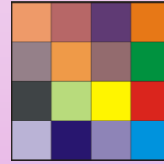
Scanning
continuous
stepped



Scanning
discrete
stepped



Snapshot
Tiled

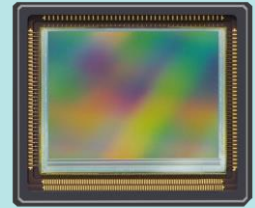
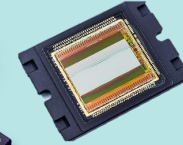
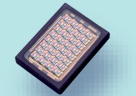


Snapshot
Bayer Mosaic



3. Image sensor

CMOS



InGaAs



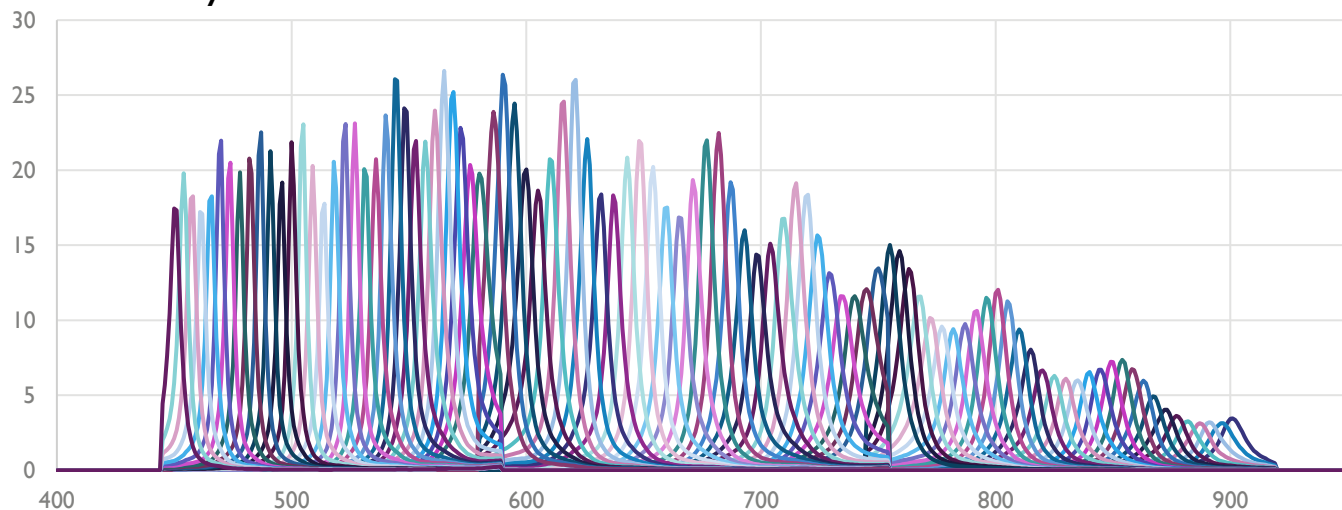
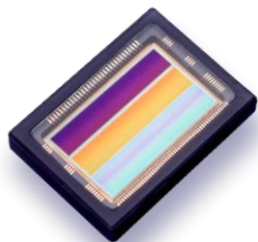
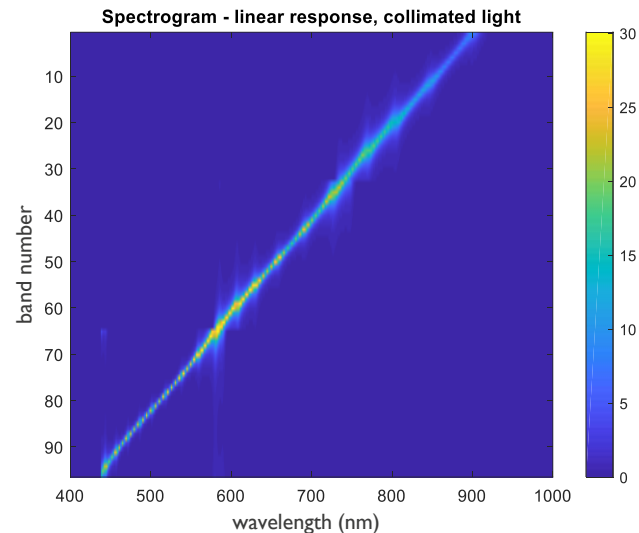
MCT



Incl. next generation imager technologies

LS96 – the successor of LSI50 (TRL9)

- Enhanced spectral range: 450-900 nm / 96 bands
- 2 x Lines per band (digital TDI): 10
- Increased sensitivity uniformity
- Improved sensor to sensor variability

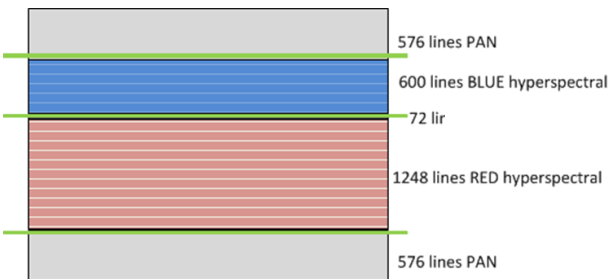
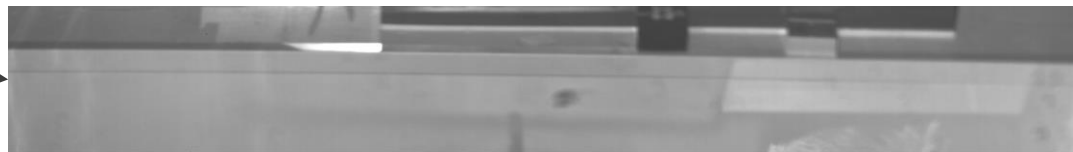




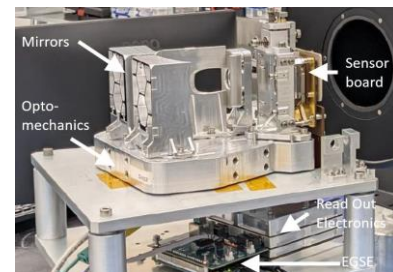
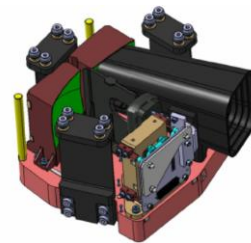
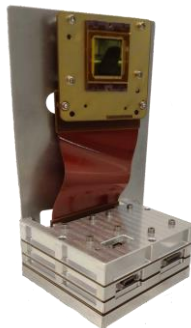
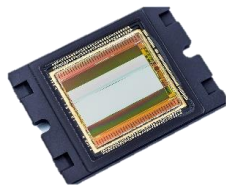
Efficient use of the focal plane for enhanced performance



First light images



- 154 spectral bands
- 12 TDI lines per band
- Panchromatic zone
- Launch in June 2025



HERA mission – asteroid characterisation with a hyperspectral snapshot imager

Hyperscout-H Cosine

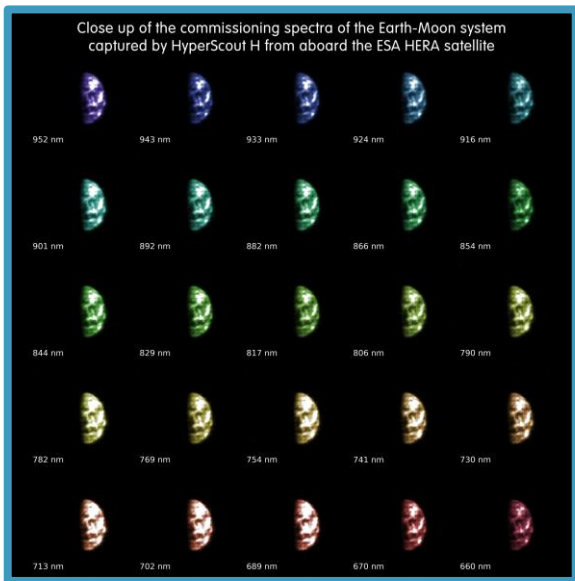
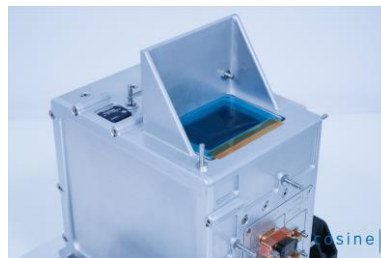
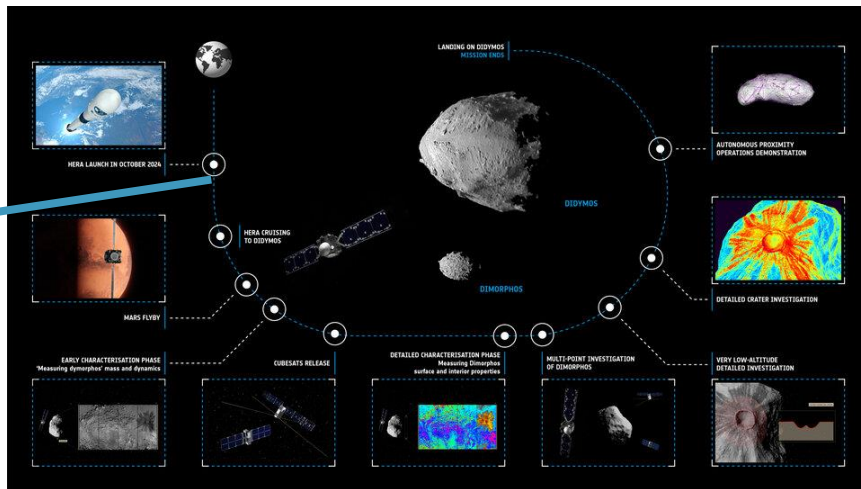
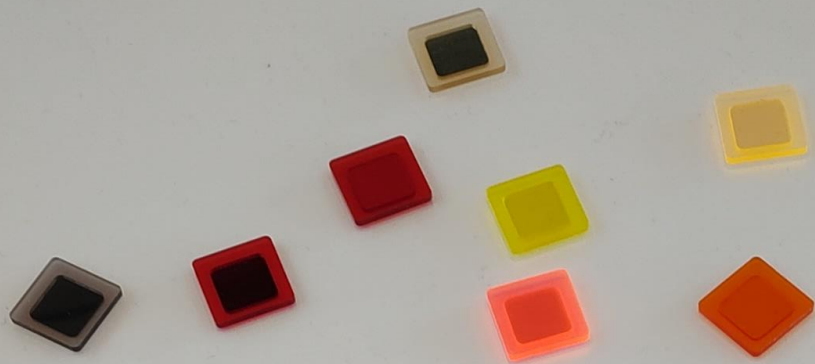


Image credits Cosine



Think out of the box – the building blocks

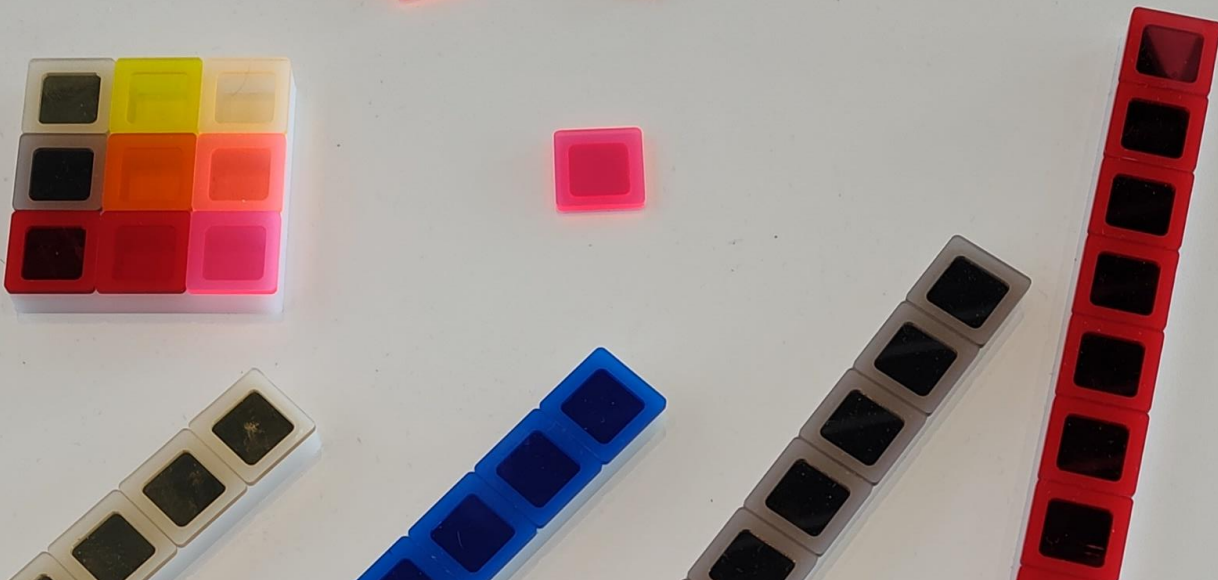
Single filter



Tile of filters



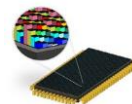
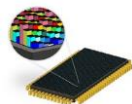
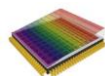
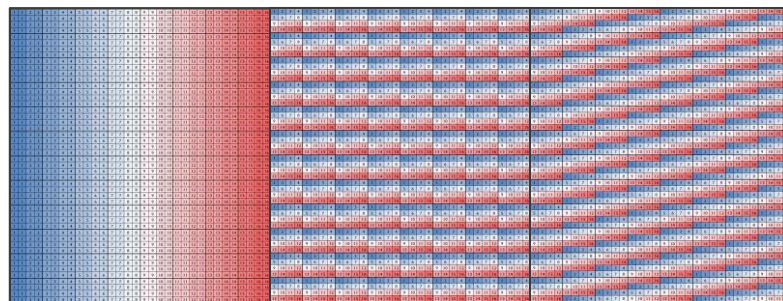
Lines of filters



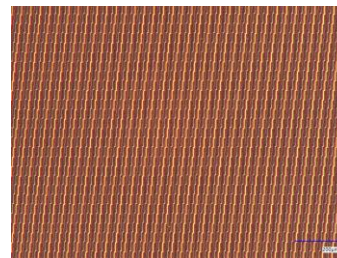
Hybrid filter pattern

1 camera - 2 imaging modes

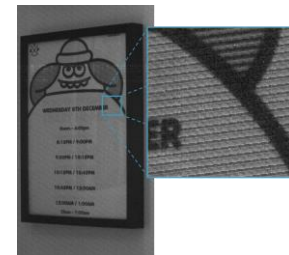
	Linear	Mosaic	Hybrid
Spectral sampling	High	Medium	High
Spatial sampling	High	Medium	High
Snapshot/video	no	yes	yes
Data output	high	low	configurable



Microscope image
650 – 900 nm (8x8)



Real image



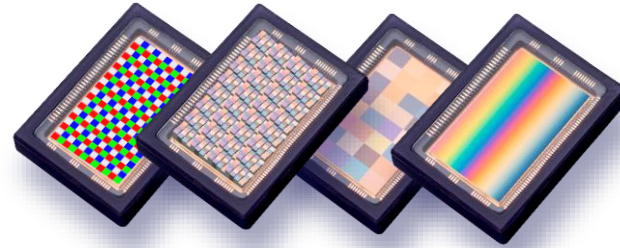
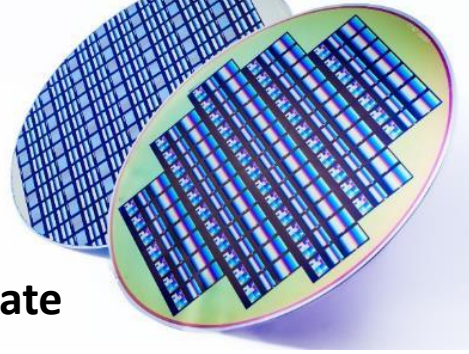
- Constellation of identical satellites
- 2 modes: snapshot vs scanning

- Snapshot overview
- Detailed scan of specific ROI

Exploiting our accurate deposition process

Welcome at our booth K41 (Hall 5)

- Our spectral detectors are **compact, robust, aligned, easy to integrate**
- Efficient use of the focal plane for **enhanced performance**
- Various filter types can be selected
- **Extreme design flexibility:** lines, mosaic, combinations, ...
- From off the shelf, customization to full design on demand
- Eager to discuss how to support your **exciting space endeavours**





mec

embracing a better life