TELEDYNE e2v
Everywhereyoulook™

Technology Developments in Earth Observation Imaging

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Space Imaging

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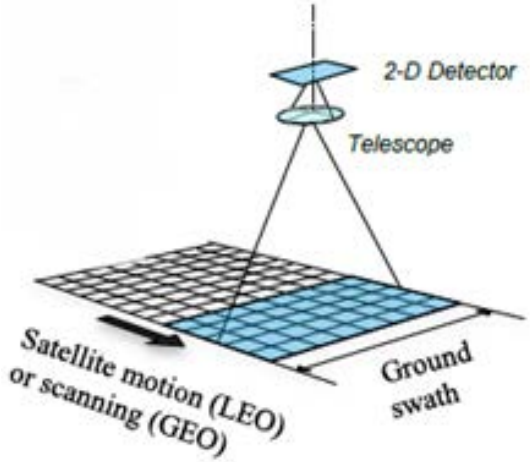
Contents

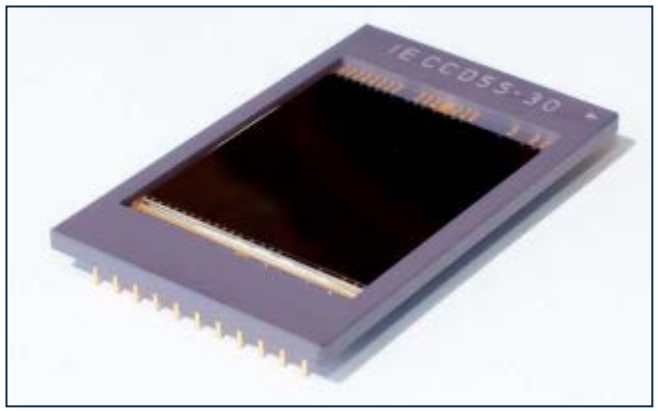
EO Imaging

Sensor Types

Snapshot Imager

- 2D detector
- Works like the detector in your digital camera
- Works for a geostationary orbit – not so good for low earth orbit
- Can be colour or monochrome

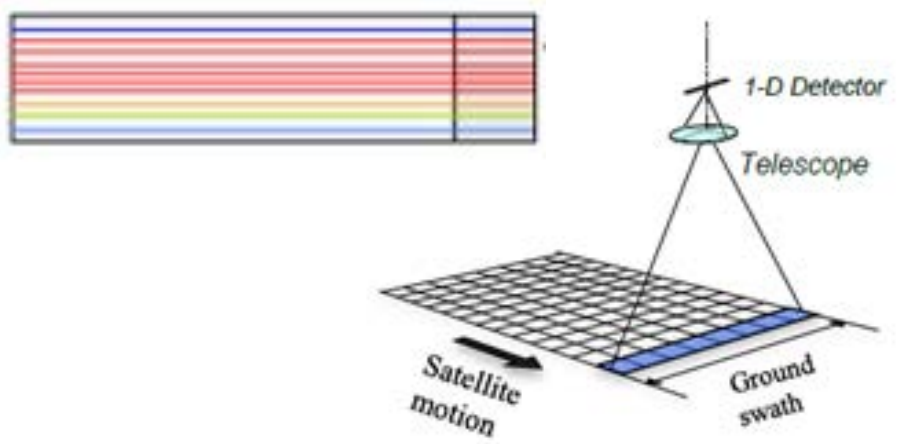




Sensor Types

Linear Imager and Multispectral

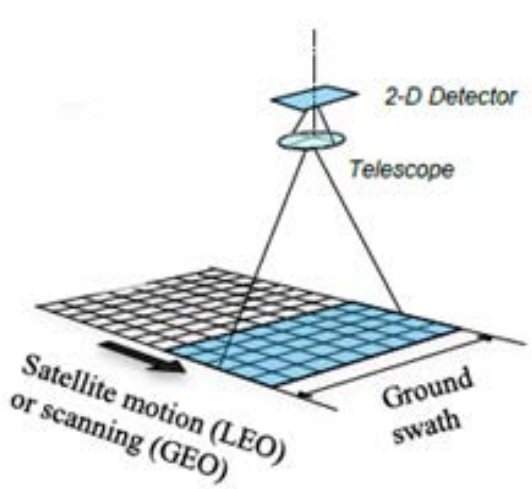
- 1D detector
- Single row of pixels
- Scans the ground like a sensor in a photocopier
- A row of pixels is formed which is swept along – **Pushbroom mode**
- **Multispectral** - Several line sensors can be used with optical filters to create a colour image
- Relatively easy transition to CMOS Imaging Sensor (CIS)

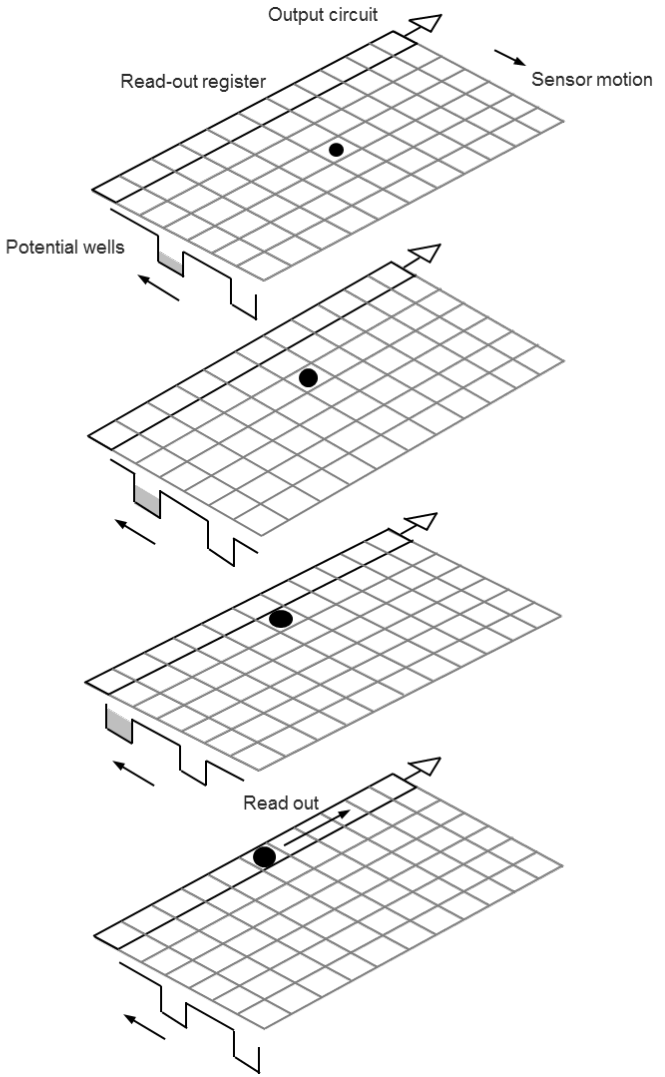


Sensor Types

TDI Imager

- 2D detector
- **Time Delay and Integration**
- Similar to linear but with multiple rows
- Charge is clocked in sync with the motion of the image across the array of elements
- Charge from several lines is effectively added on chip increasing sensitivity to low light

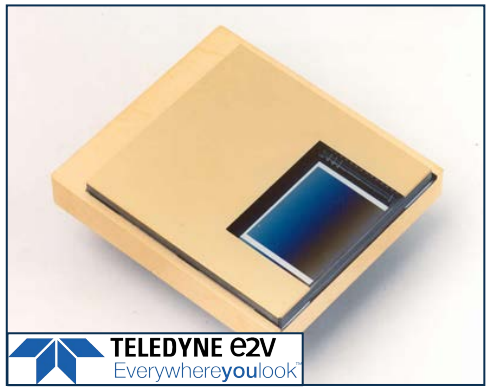


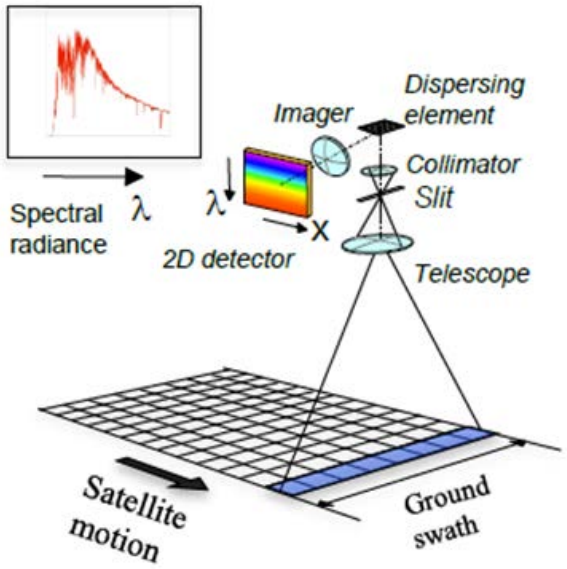


Sensor Types

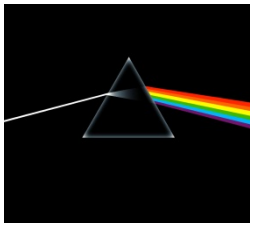
Hyperspectral Imagers

- 2D sensors
- Spectrum is dispersed across a 2D array
- **Hyperspectral** - Graded AR coating on a single image area
- Lower spatial resolution typically but higher spectral resolution

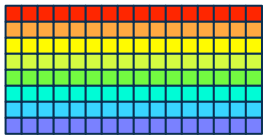




One line from the ground



Is split into spectral lines



And imaged as many lines on a detector

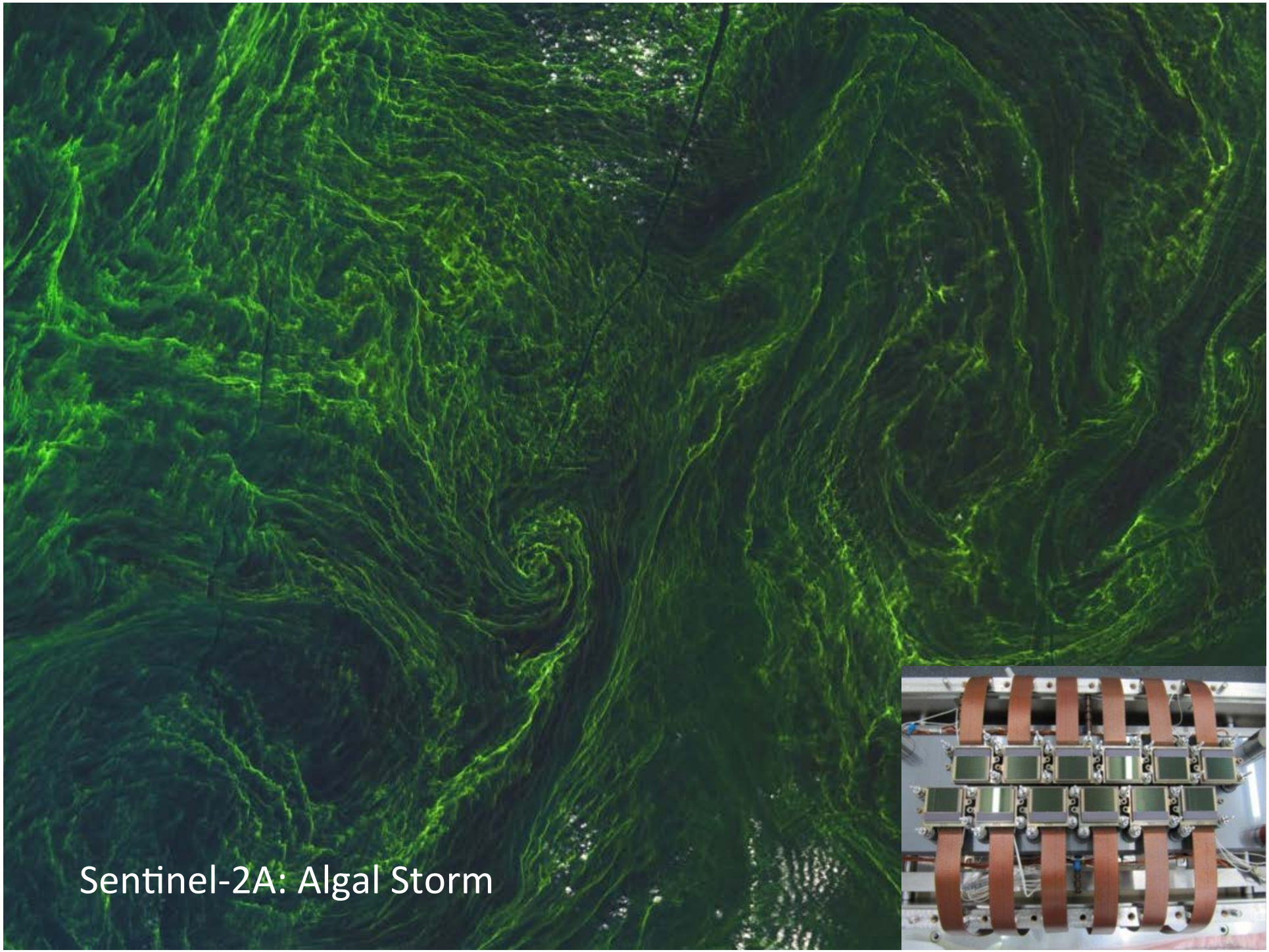
Example Images

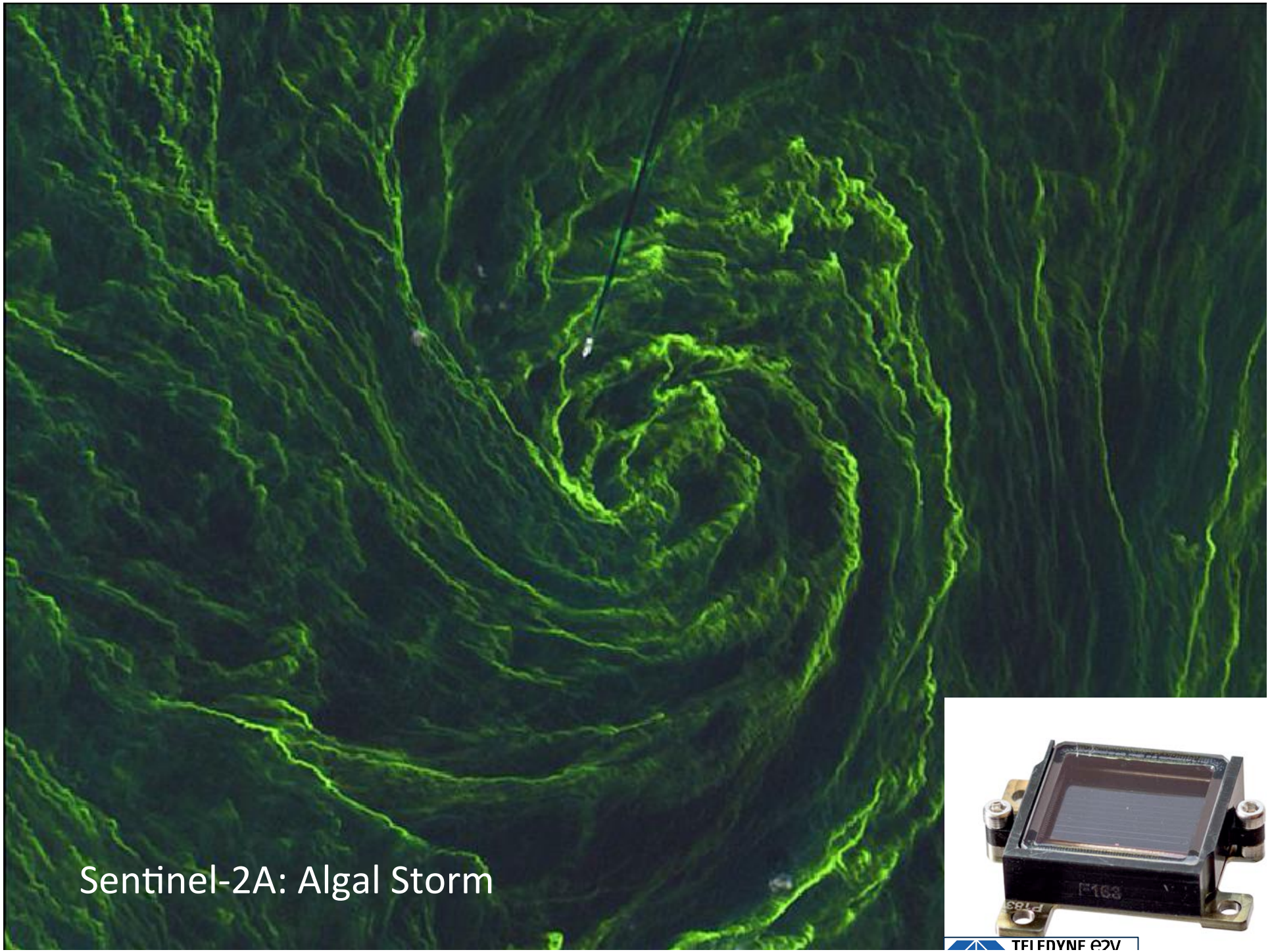
Linear Monochromatic CCD21-40 Imager

Example Images

Pleiades Moores Oklahoma Tornado

e2v inside ESA Sentinel 3A


Sentinel-2A: Algal Storm


Sentinel-2A: Algal Storm

The Present

Technology Summary

	Snapshot Imager	Linear and Multispectral	TDI	Hyperspectral
Summary	Geostationary Orbit	Single row Composite colour images	Multiple rows Better sensitivity to low light	Graded AR coating High spectral resolution

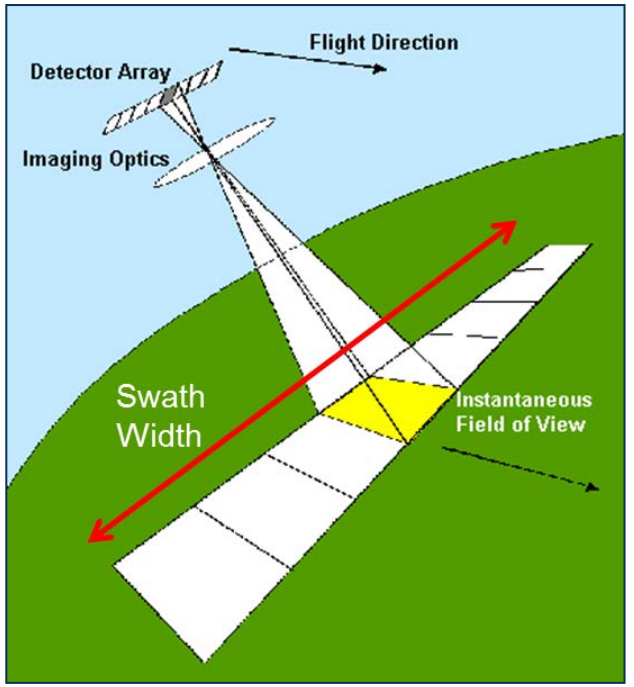
The Future

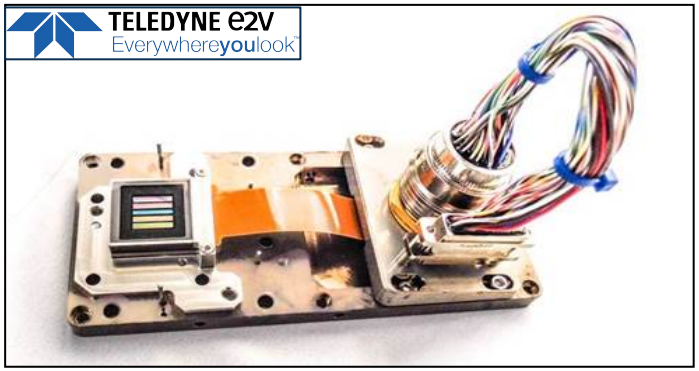
Challenges

- Mission Requirements:
  - Increased swath widths
  - Higher ground resolution (or GSD)
- System Requirements (Image Sensor):
  - Longer sensors
  - Smaller pixels
  - More columns

→ Requires faster readout rates!

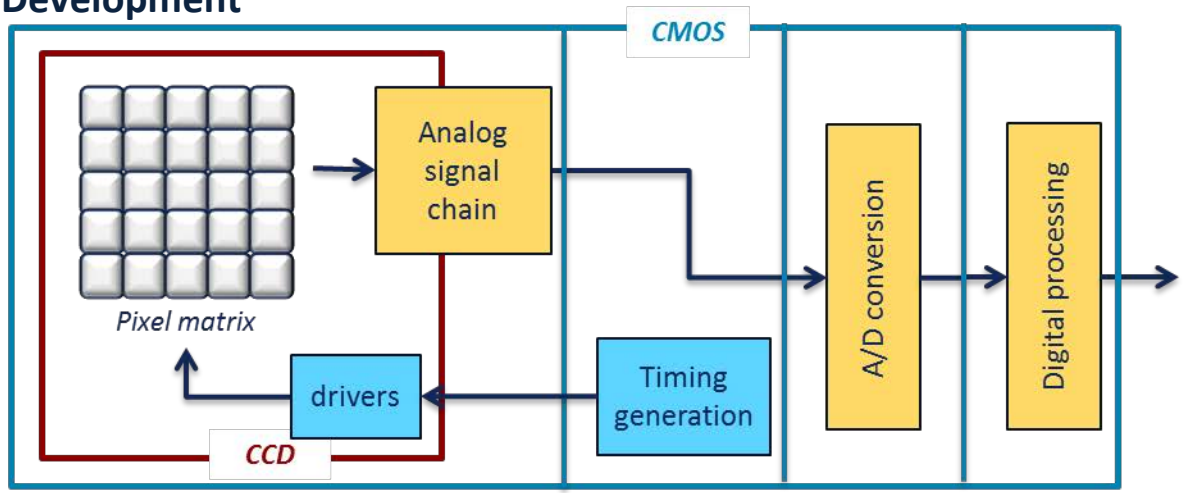
- CMOS Earth Observation devices





The Future

CMOS Imaging Sensor Development



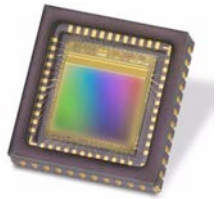
Rad-tolerant devices

CIS113

CIS115

(MTG FCI) or (METImage_FM)

CIS120 (GPSI)



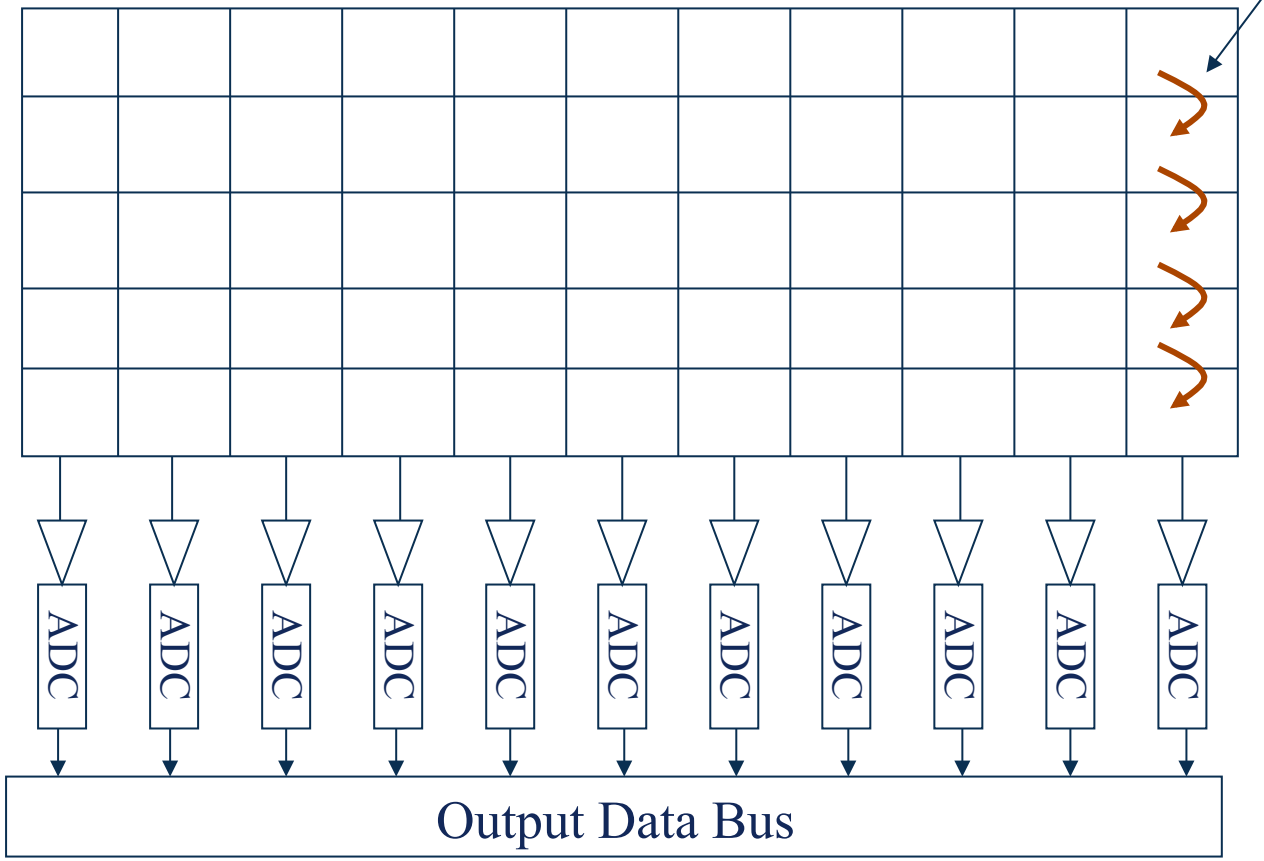
R&D program

indus devices

Jade, Sapphire, Onyx

The Future

TDI CMOS



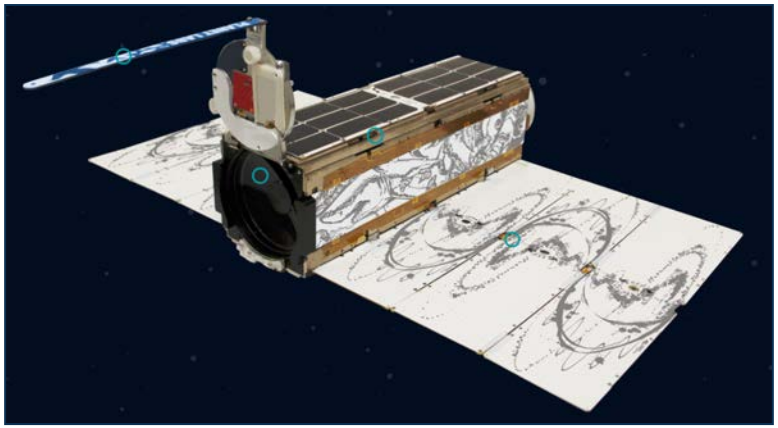
Charge is transferred within the array in a similar manner to a CCD but can give reduced power consumption and lower noise

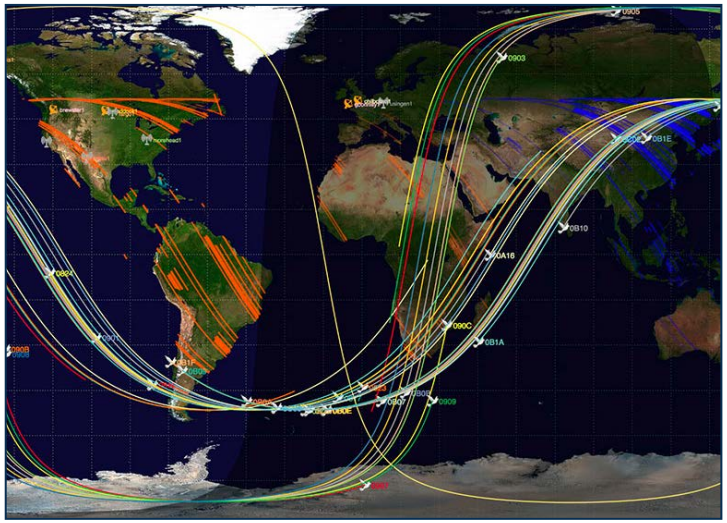
When the charge reaches the bottom line it is read out though a column-parallel ADC circuit to give high line rates and low noise

Low Cost Systems

Nanosats

- 1 – 10 kg
- 10 x 10 x 10 cm^3
- Doves/ Constellations
- **Resolution – ground coverage – low cost – pass time**
- **Reliability? Stability? Quality?**

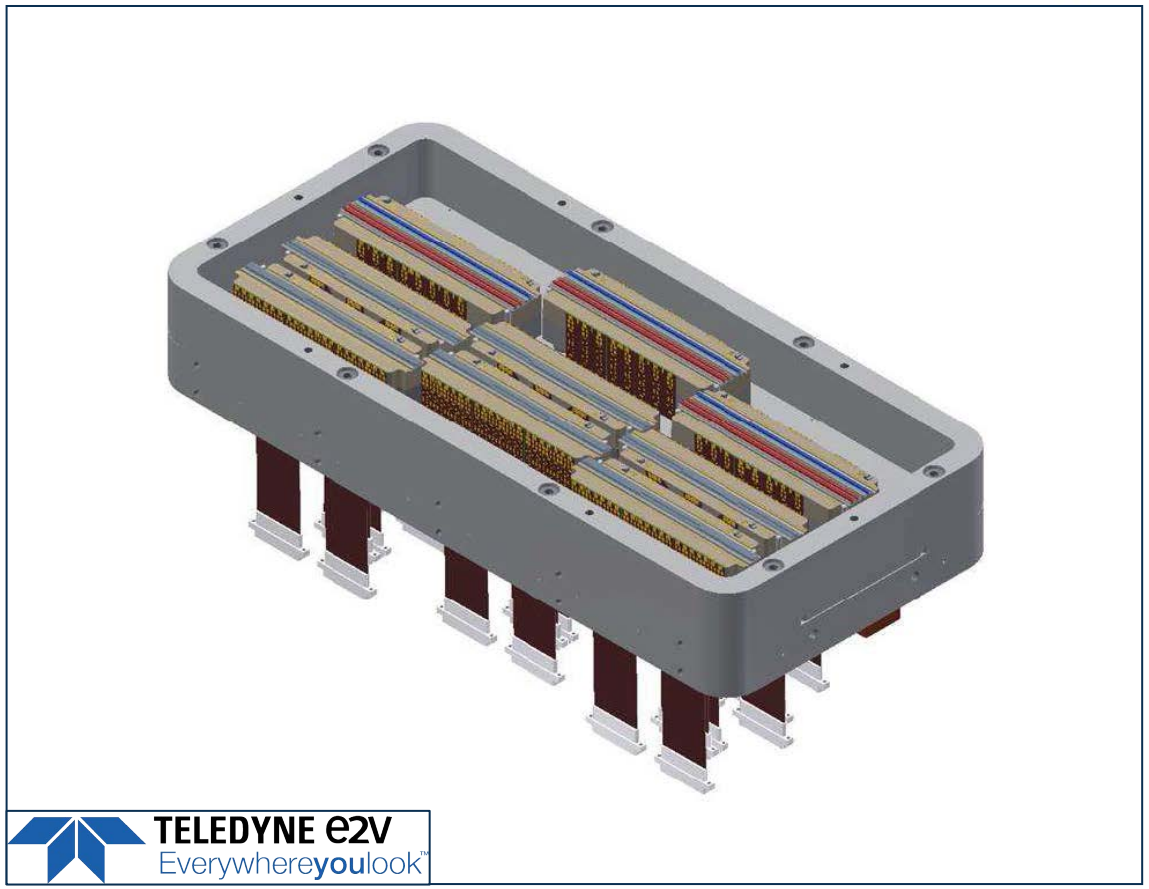


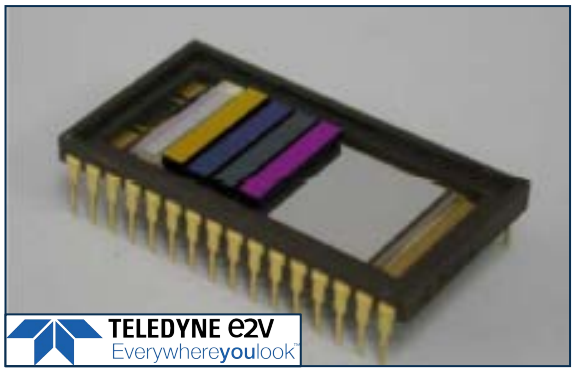


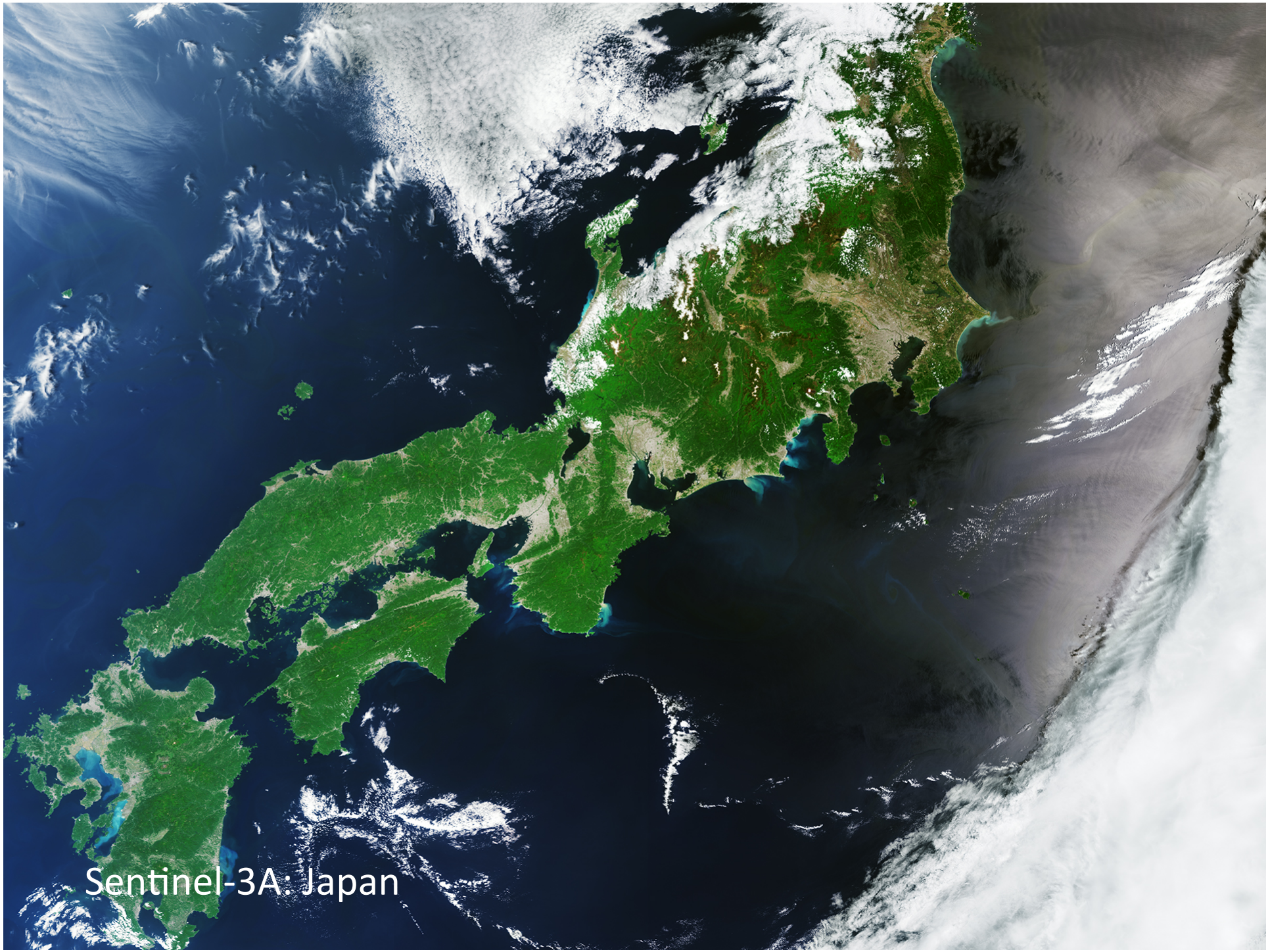
Solutions

System Solutions

- TDI CMOS
- Focal Plane Arrays
- Filter Integration






Sentinel-3A: Japan

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OUR INNOVATIONS LEAD DEVELOPMENTS IN COMMUNICATIONS, AUTOMATION, DISCOVERY, HEALTHCARE AND THE ENVIRONMENT

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