

Avoiding sensor overload: UAS sensor fundamentals for mapping professionals

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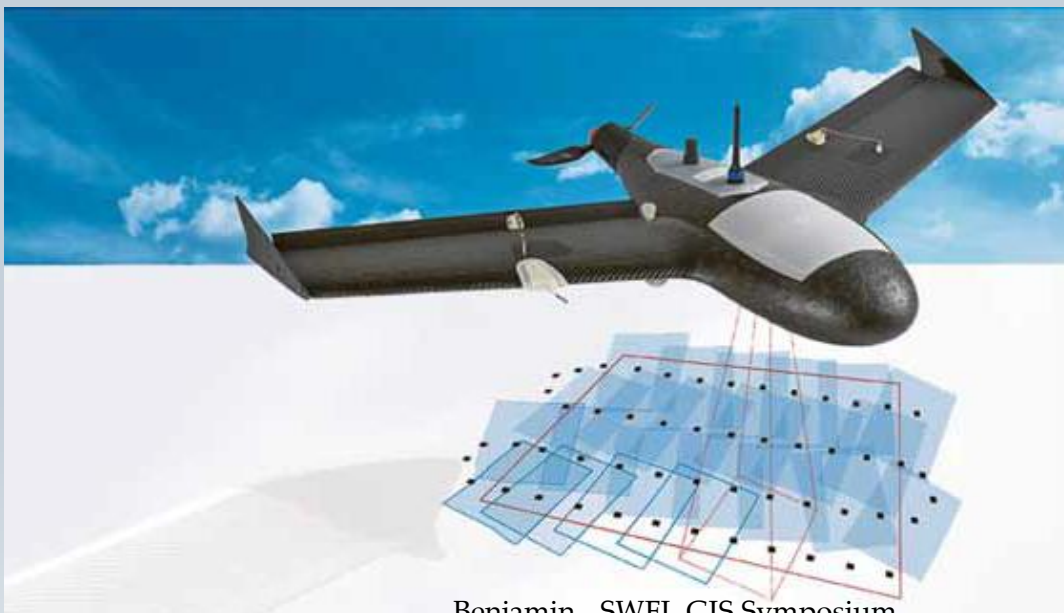
November 7, 2019
SWFL GIS Symposium

UAS Sensors & Payloads

- UAS Background
- Imaging Sensors/Payloads

UAS Background: Why UAS Aerial Imaging?

- Fills cost effective niche in geospatial data acquisition between traditional surveying technologies and traditional photogrammetry
- Rapid mobilization/deployment for sUAS
- High spatial res. (GSD) data acquisition
 - f(flying height, side/end overlap)



UAS Background: Why UAS Aerial Imaging?



UAS Background: Why UAS Aerial Imaging?



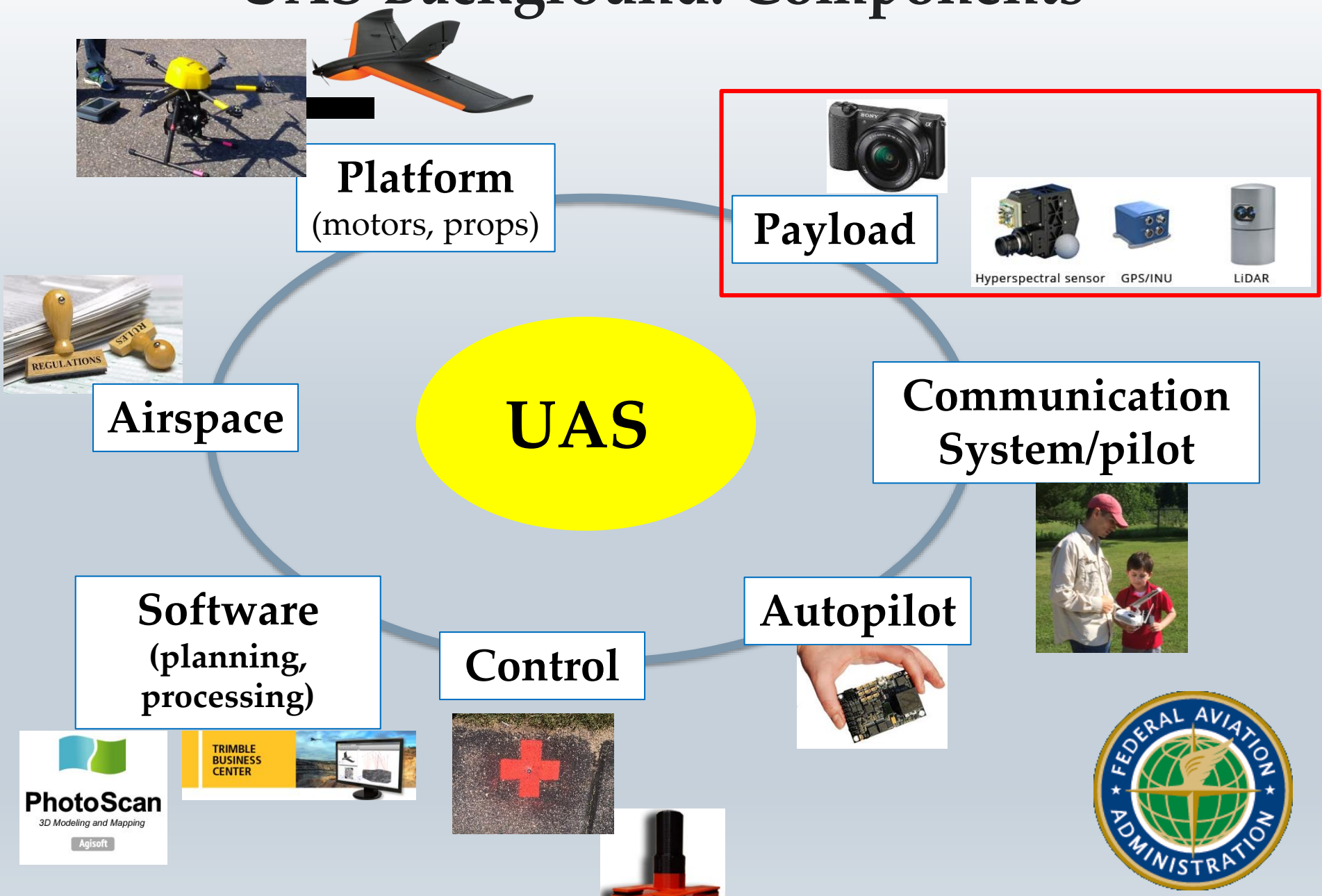
NAIP Imagery

Orthophoto Mosaic – ZX5 – 100m

UAS Background: Why UAS Aerial Imaging?

UAS imagery can be processed to provide high spatial resolution maps that other data sources cannot match in terms of quality

UAS Background: Components



Sensors & Payloads

For discussion:

- **Imaging**
 - **RGB (Images & Video)**
 - **IR (Images)**
 - **Multispectral, Thermal, Hyperspectral**
 - **Lidar (Point Clouds)**
- **Non-Imaging**
 - **Power Sources**
 - **Air Quality Monitoring**
 - **Water Sampling**
 - **Spray/Release Devices**

Imaging PL: RGB (Images & Videos)

Examples/Typical Uses:

- **RGB: most common imaging UAS sensor**



Sony DSLR
(Image/Video)



DJI Phantom
(Image/Video)



eBee SODA 3D
(2 oblique/1 nadir)



MAVIC 2 PRO

Hasselblad L1D-20c Camera
Iconic Image Quality

20 MP 1" CMOS Sensor

Adjustable Aperture, f/2.8 - f/11

10-bit Dlog-M

10-bit HDR Video

MAVIC 2 ZOOM

24-48 mm Optical Zoom Camera
Ultimate Flexibility

12 MP 1/2.3" CMOS Sensor

48 MP Super Resolution Photo

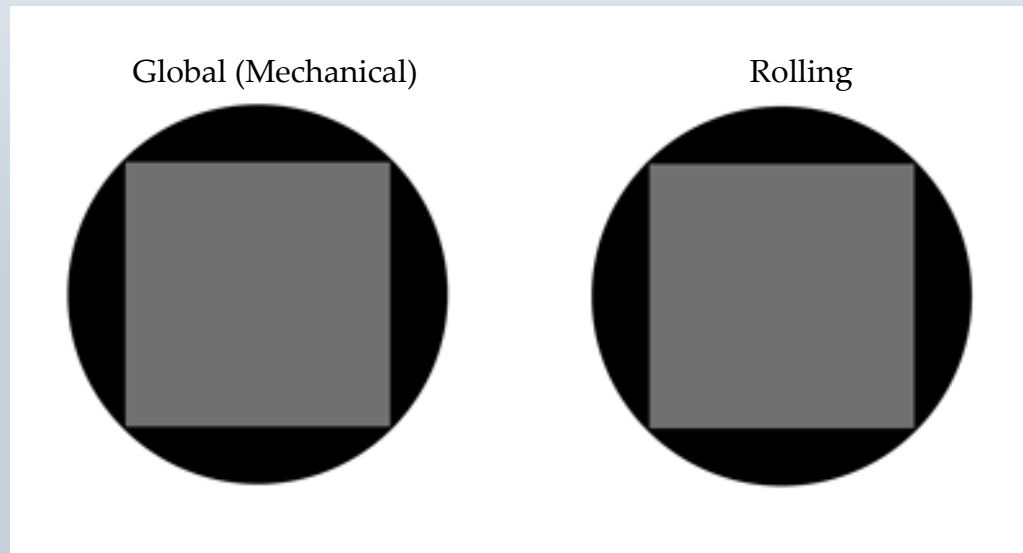
4x Lossless Zoom FHD Video

Dolly Zoom

Imaging PL: RGB (Images & Videos)

Important Considerations:

- Camera shutter

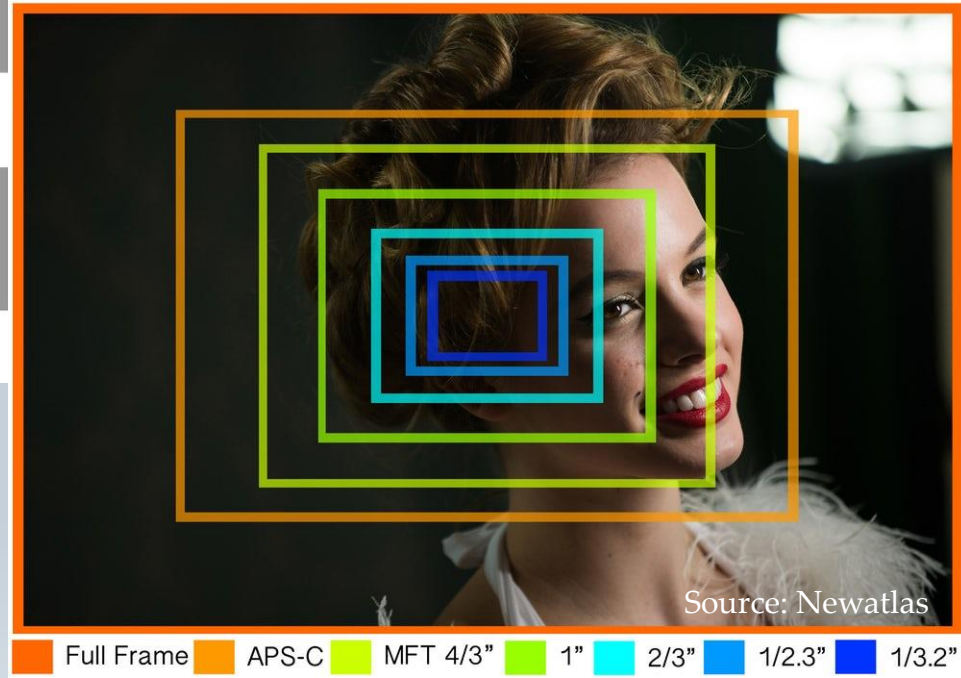
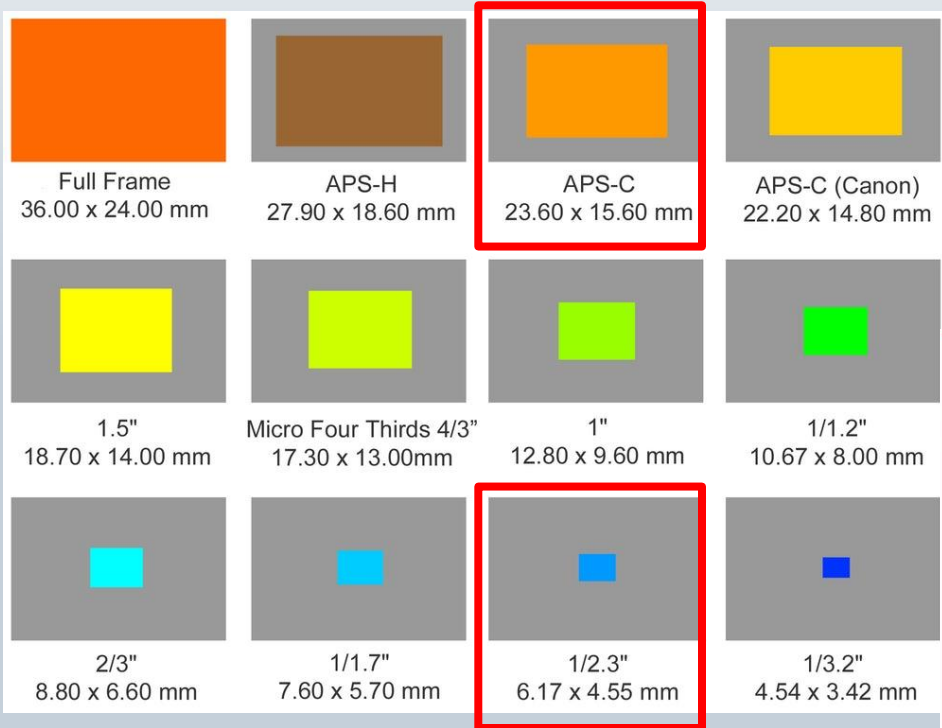


Source: Pix4D

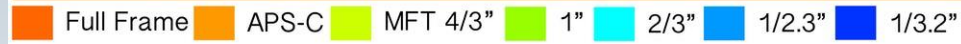
Imaging PL: RGB (Images & Videos)

Important Considerations:

- Physical sensor matters → FOV



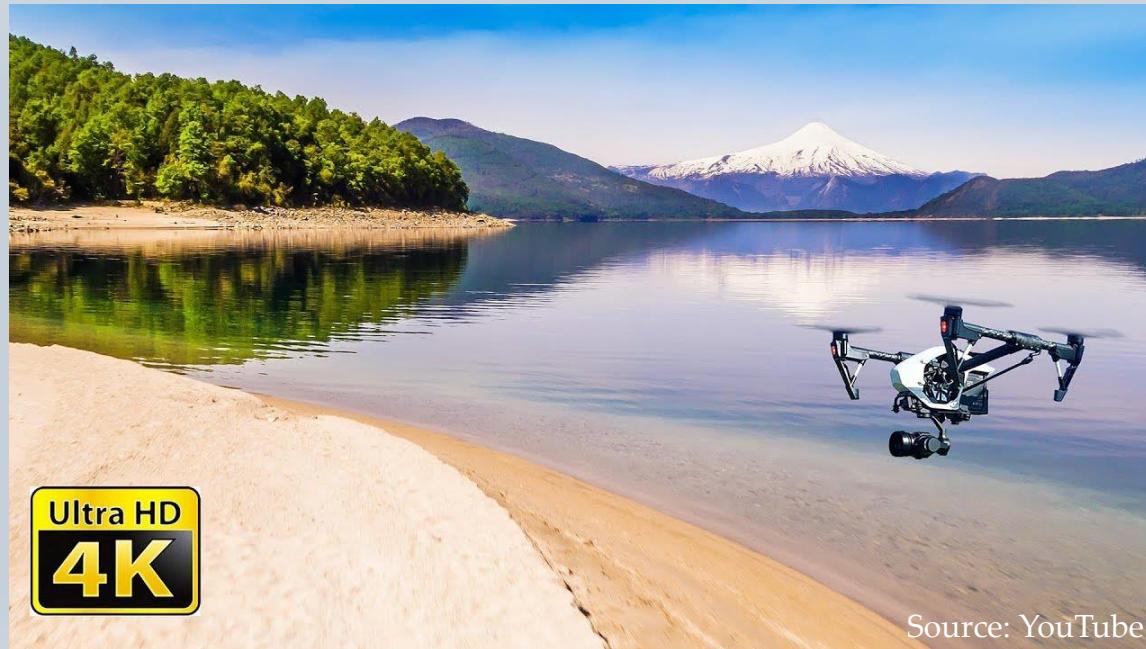
Source: Newatlas



Imaging PL: RGB (Images & Videos)

Important Considerations:

- Platforms (fixed wing vs VTOL) contribute to feasibility and quality of video
- For video, determine end product needs
 - 4K HD is data intensive

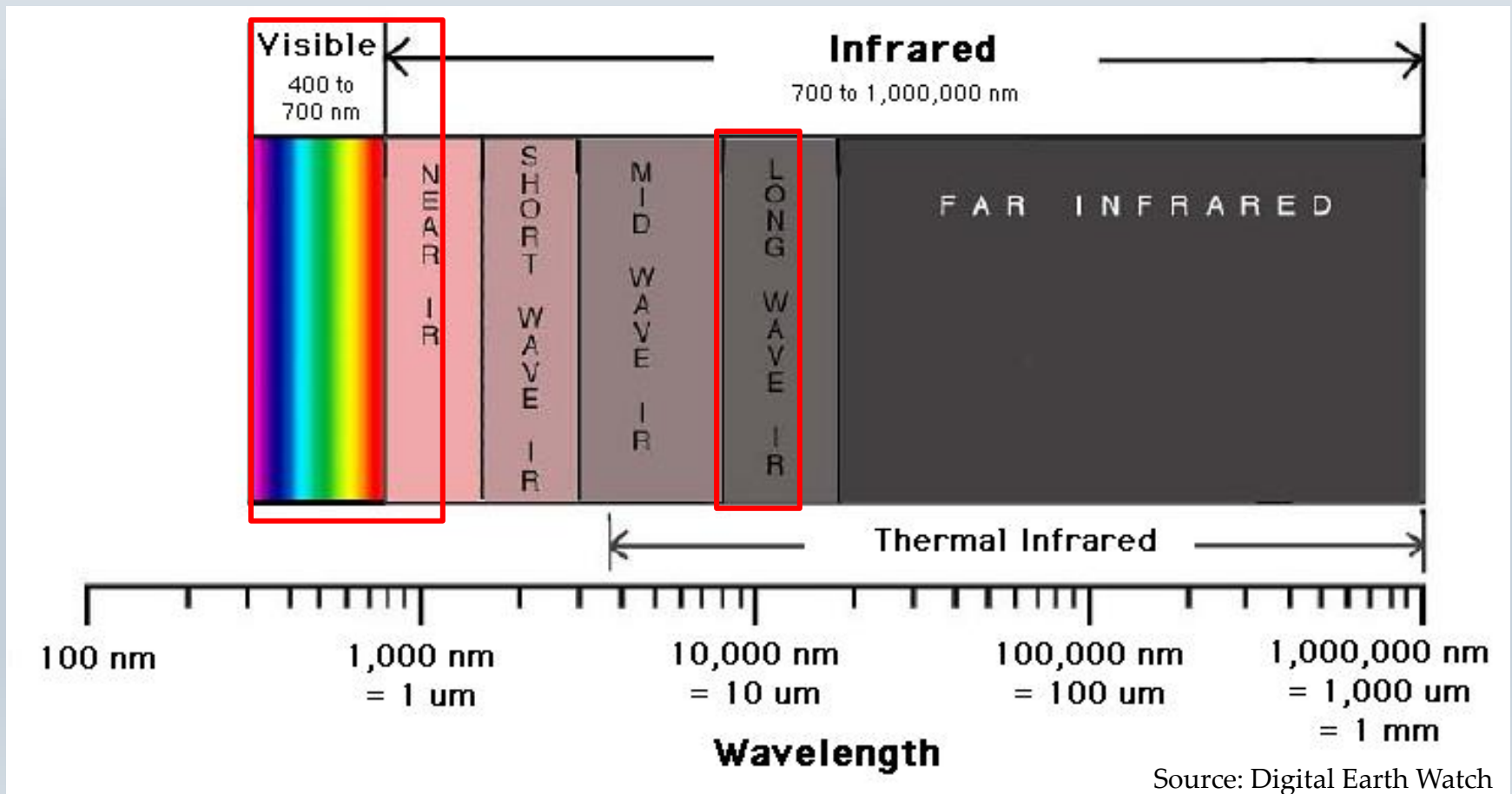


4K 60 fps drone footage - Patagonia (YT)

Imaging PL: IR (Images)

Technology Overview:

- Electromagnetic Spectrum:
 - Vis & NIR (400-1000nm) for veg
 - LWIR (8-15 μ m) for thermal

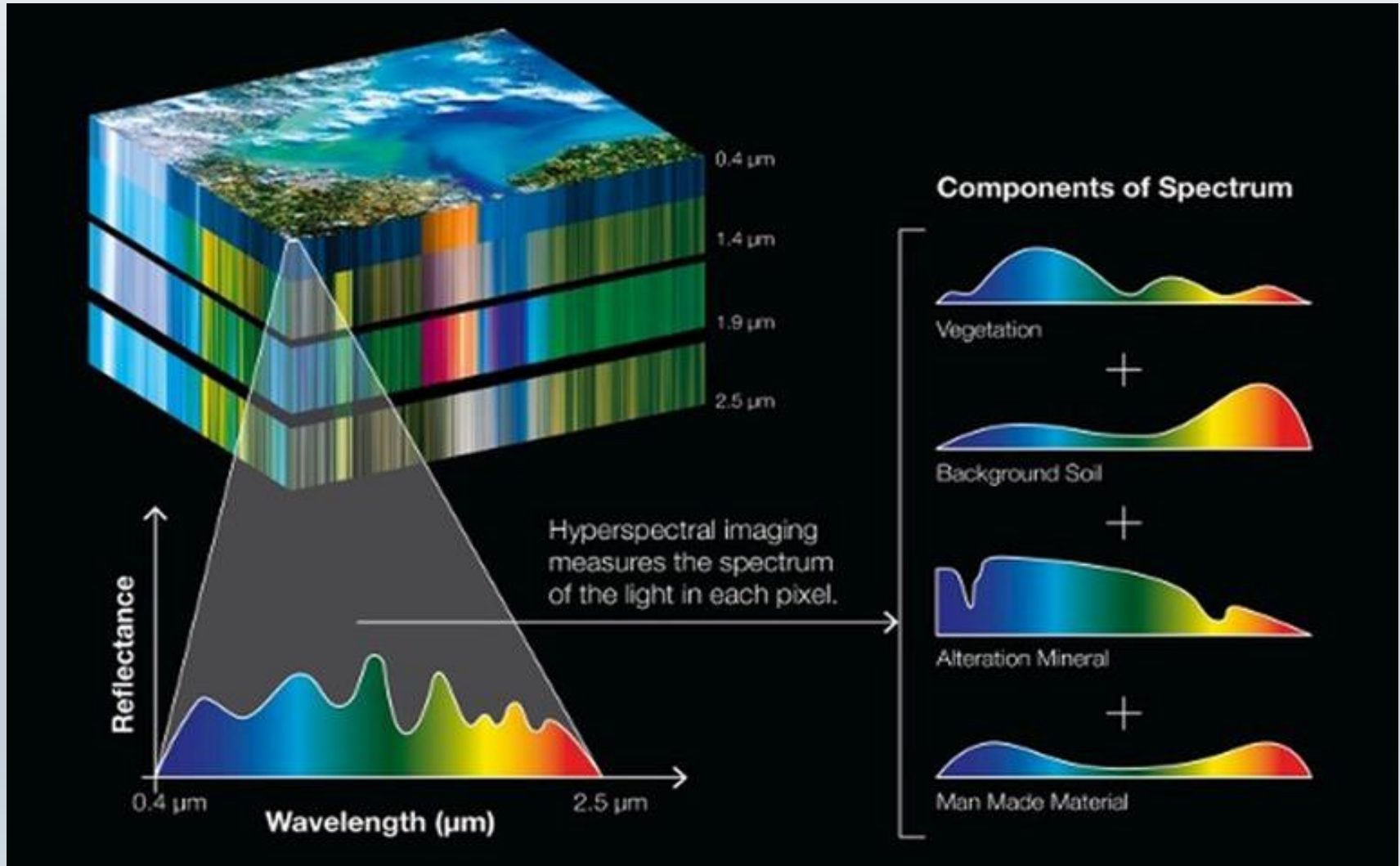


Source: Digital Earth Watch

Imaging PL: IR (Images)

Technology Overview:

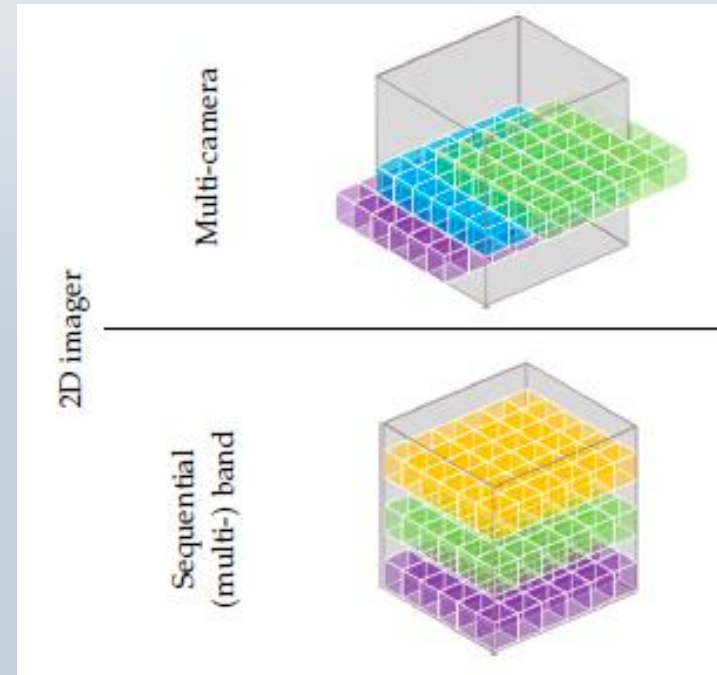
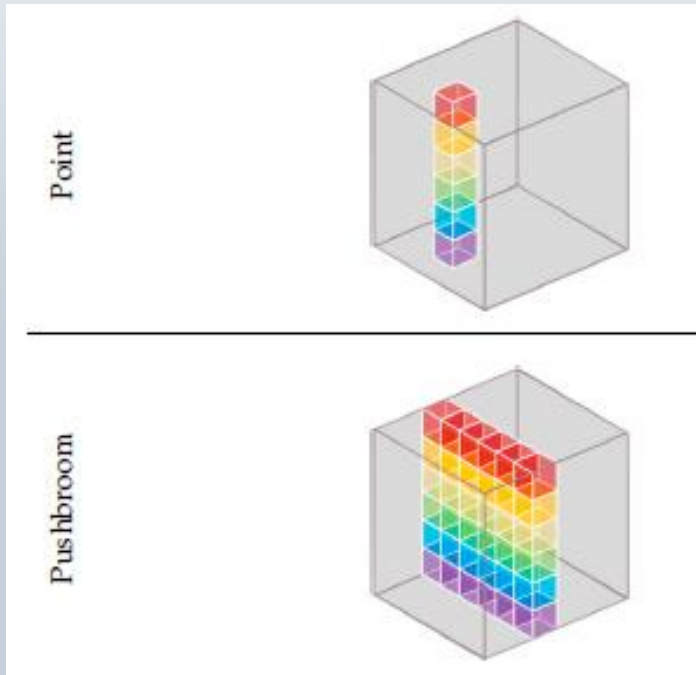
- Electromagnetic Spectrum:



Imaging PL: IR (Images)

Technology Overview:

- IR sensor data capture techniques
 - Impacts how image/data cube is produced



Imaging PL: IR (Images)

Examples/Typical Uses:

- **Multispectral: 4-5 bands (1-2 NIR)**



MicaSense RedEdge



Parrot Sequoia

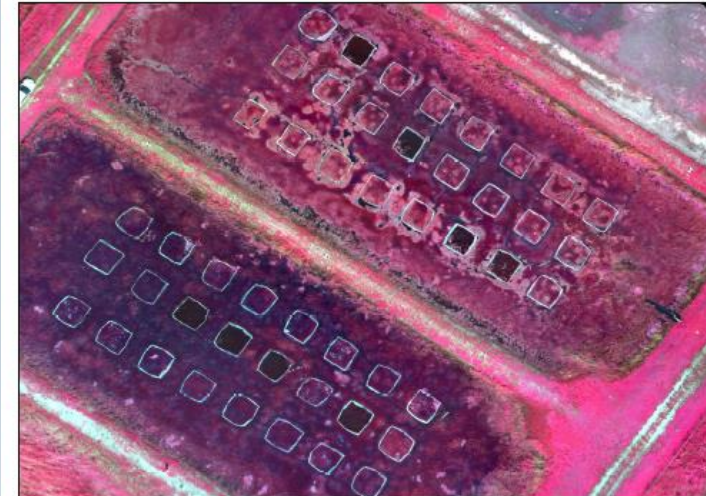
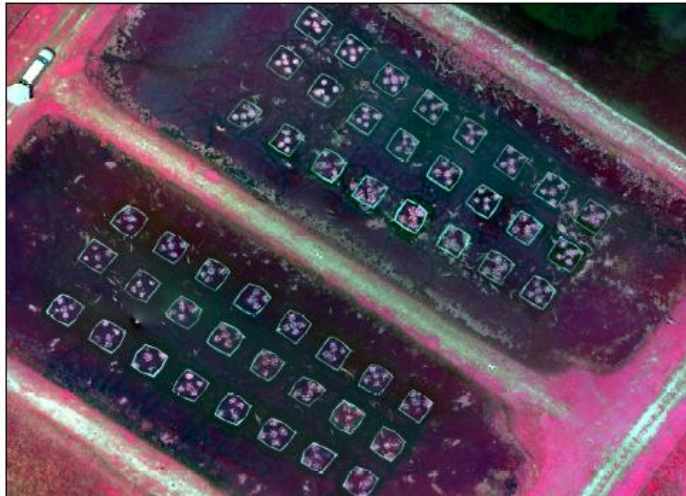


SlantRange 4P+

STA1W - TEST CELLS - 2017/08/16



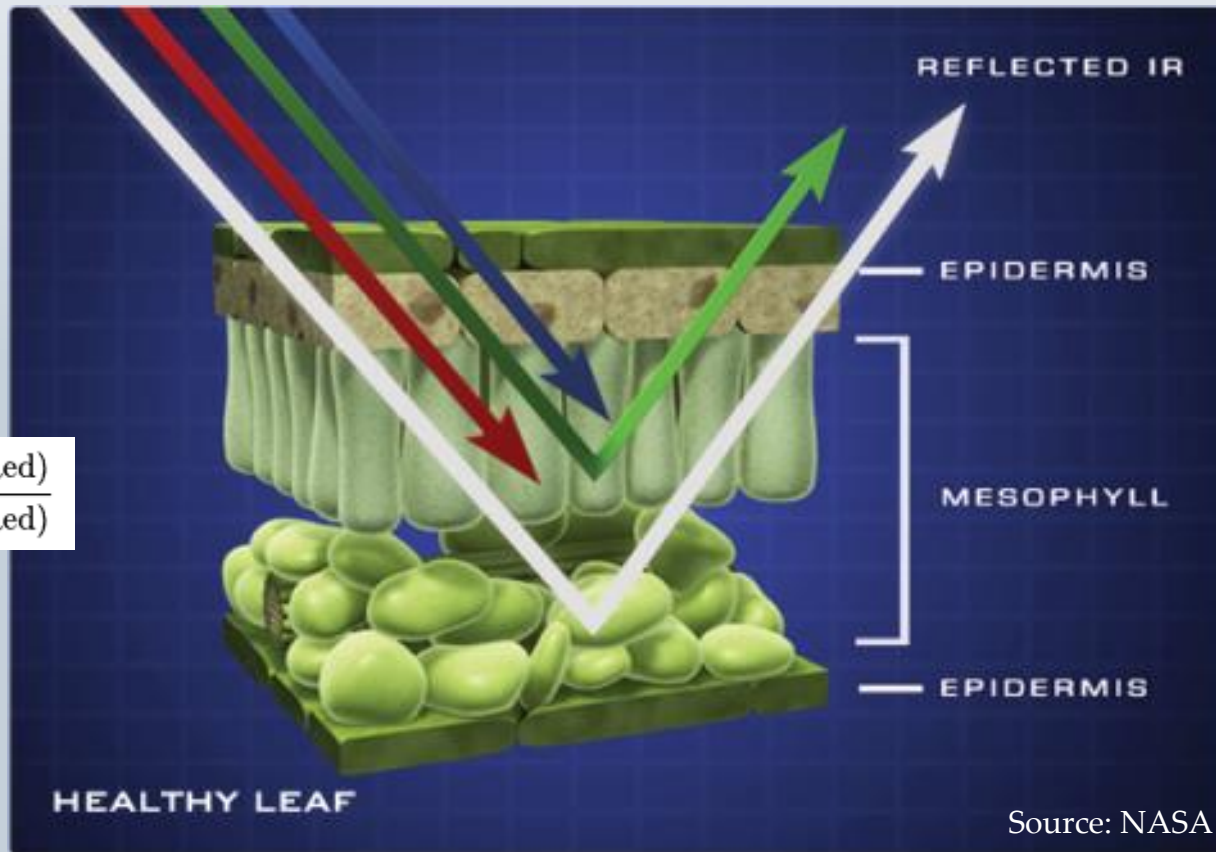
STA1W - TEST CELLS - 2017/10/11



Imaging PL: IR (Images)

Examples/Typical Uses:

- **Multispectral: Absorption & Reflectance Principles**

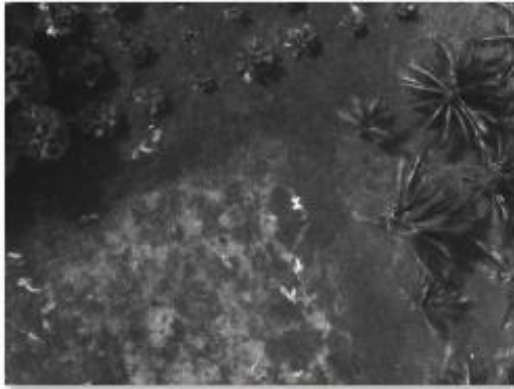


$$\text{NDVI} = \frac{(\text{NIR} - \text{Red})}{(\text{NIR} + \text{Red})}$$

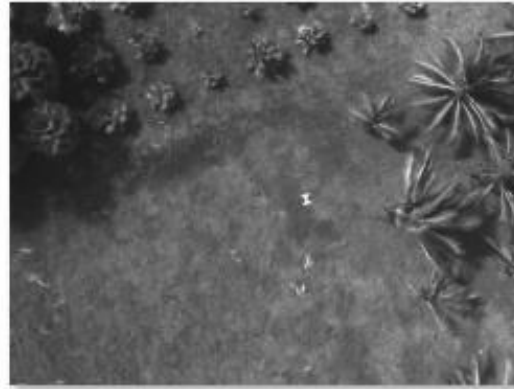
Imaging PL: IR (Images)

Examples/Typical Uses:

- **Multispectral: Multi-camera output example (RedEdge)**



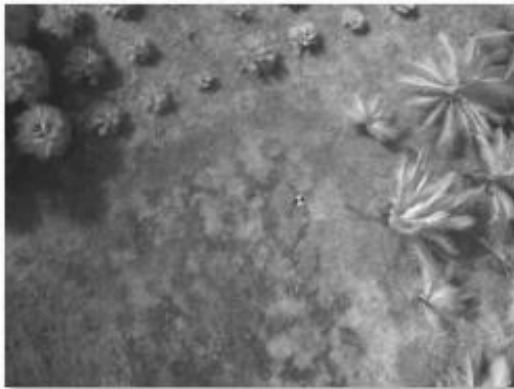
Blue (475nm) IMG_0015_1



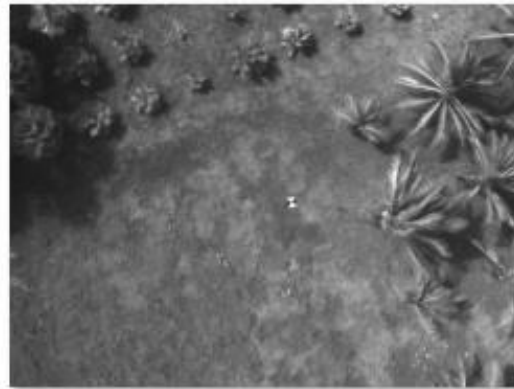
Green (560nm) IMG_0015_2



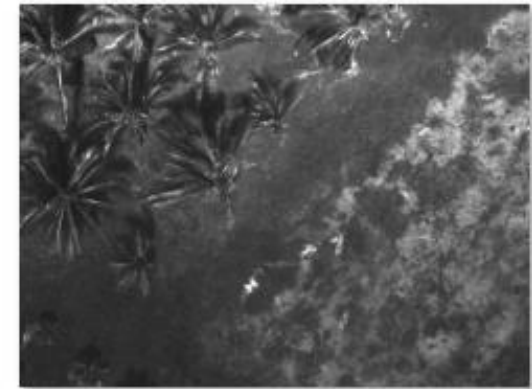
Red (668nm) IMG_0015_3



NIR (840nm) IMG_0015_4



RedEdge (717nm) IMG_0015_5

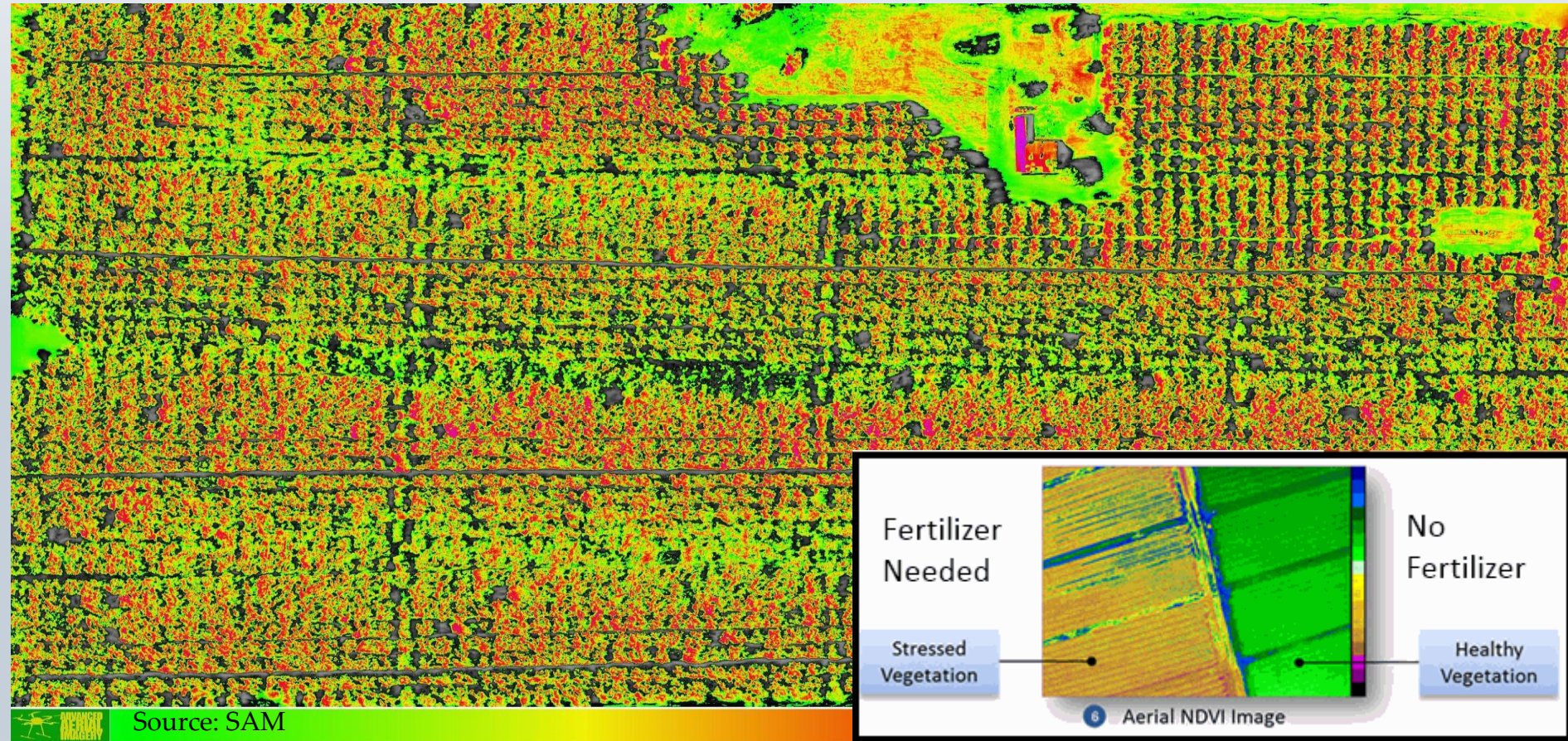


Blue (475nm) IMG_0016_1

Imaging PL: IR (Images)

Examples/Typical Uses:

- **Multispectral: vegetation health (NDVI)**



Imaging PL: IR (Images)

Examples/Typical Uses:

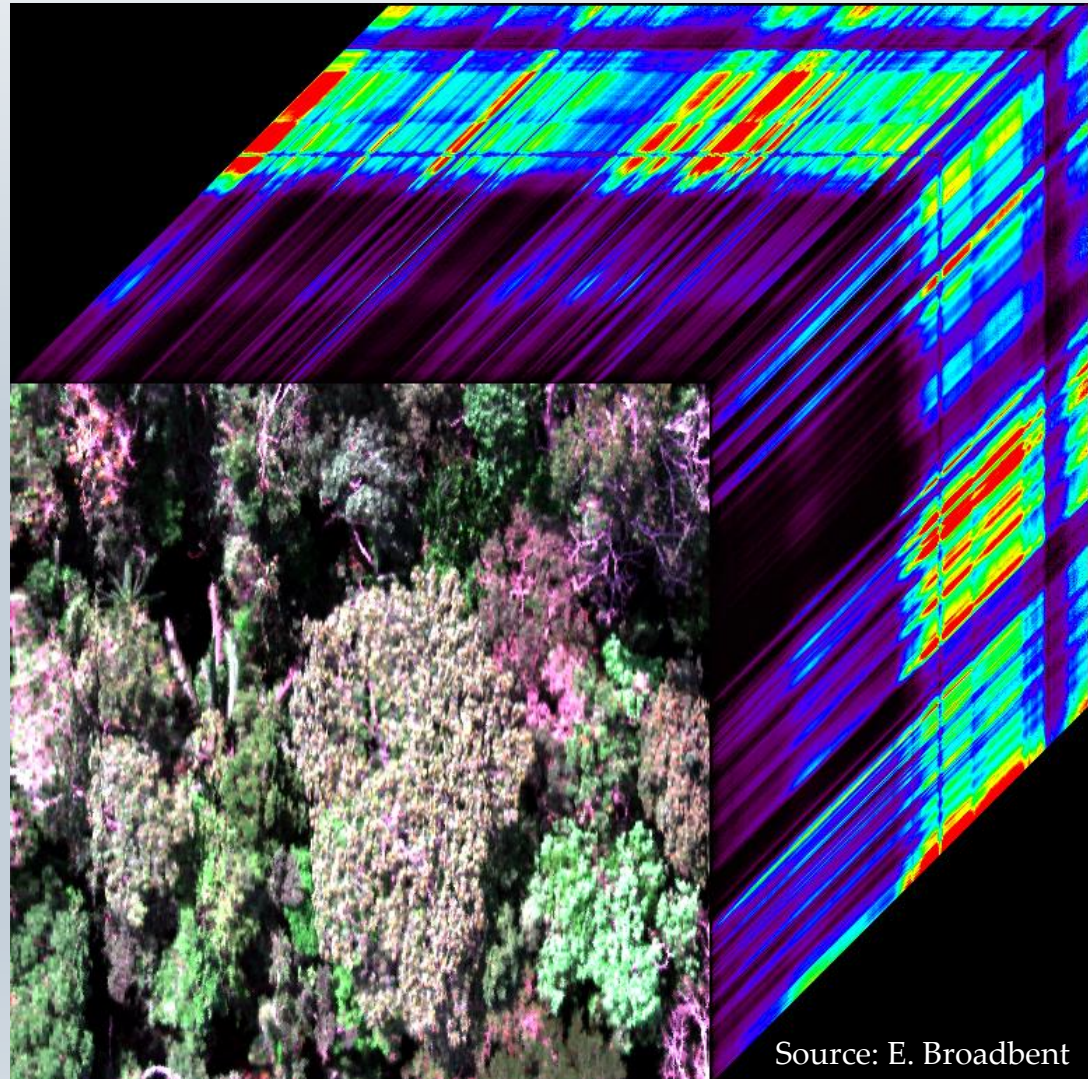
- **Hyperspectral: Diversity, Species, Status/stress, Nutrients**



SPECIM
AisaKESTREL



Headwall
Nano-Hyperspec



Imaging PL: IR (Images)

Examples/Typical Uses:

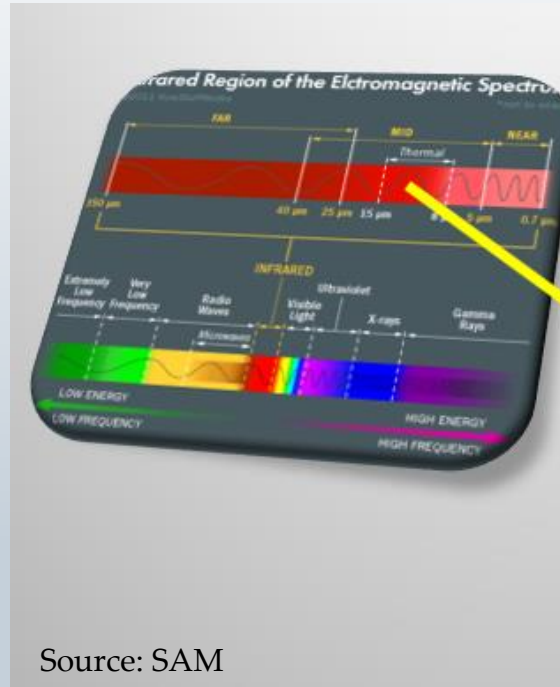
- Thermal: 8-15 μm



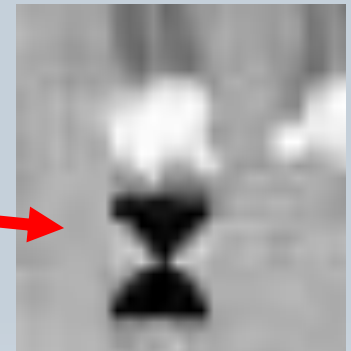
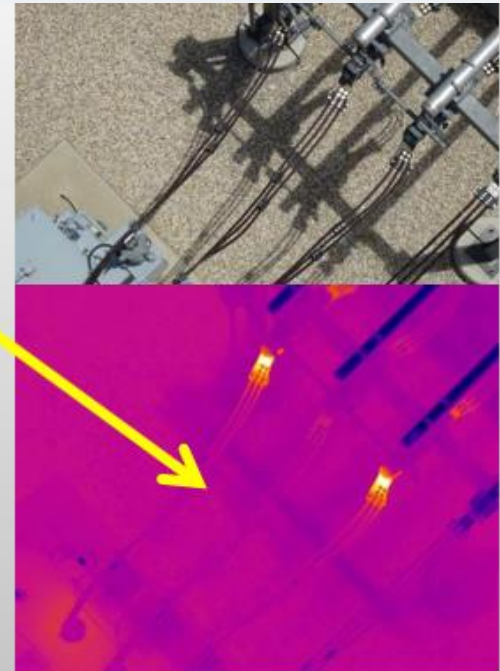
FLIR
Zenmuse XT



FLIR
Zenmuse XT2



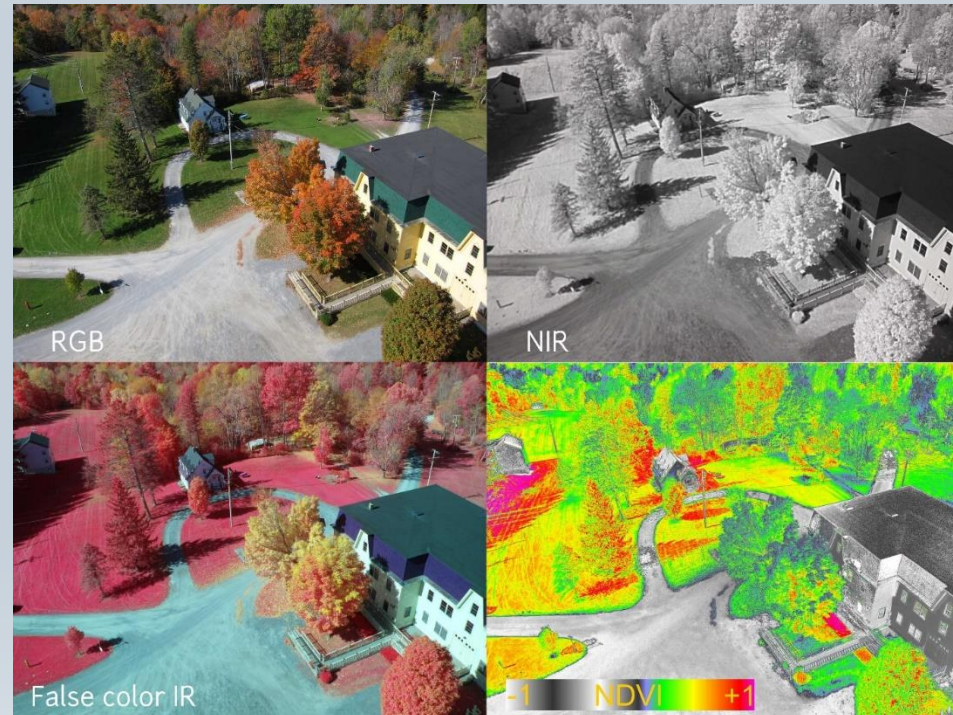
Source: SAM



Imaging PL: IR (Images)

Important Considerations:

- Data capture technique → high accuracy INS may be required (expensive!)
- Consider spat. res. req. for given application
 - Community vs species classification
 - Thermal typically poor spat. res.
- Conversion of irradiance to reflectance (MS/HS)
 - Radiometric calibration!
- Buyer beware on simple, OTS cloud-based processing solutions



Imaging PL: Lidar (Point Clouds)

Examples/Typical Uses:

- Lidar



Velodyne
VLP-16



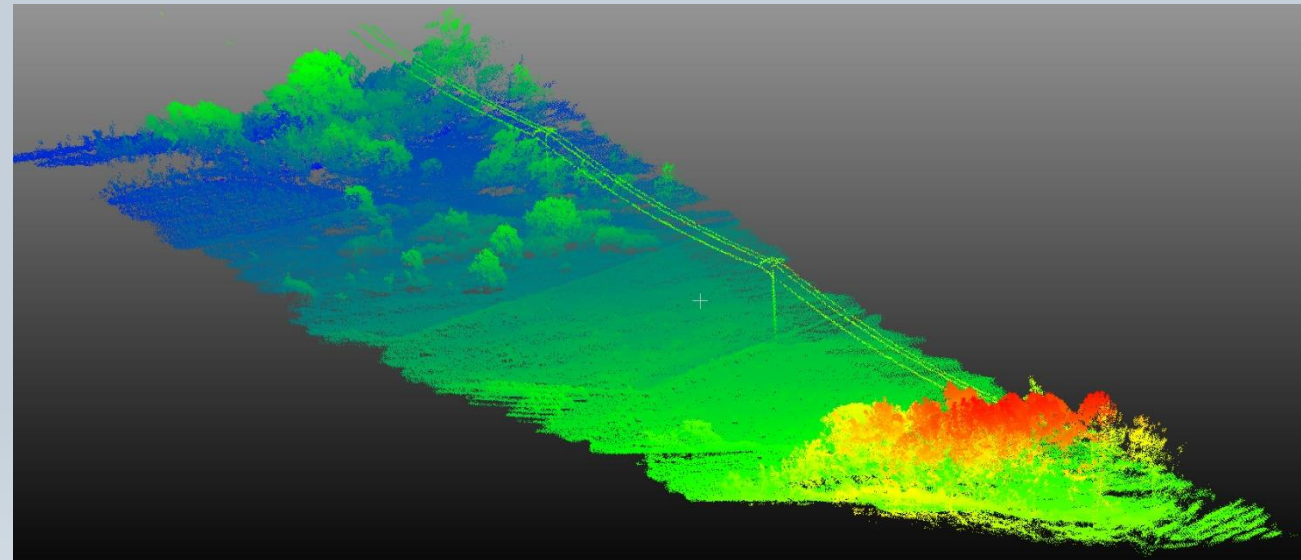
Riegl
VUX-1UAV

UF Stadium Lidar



GeoSLAM
Zeb Horizon

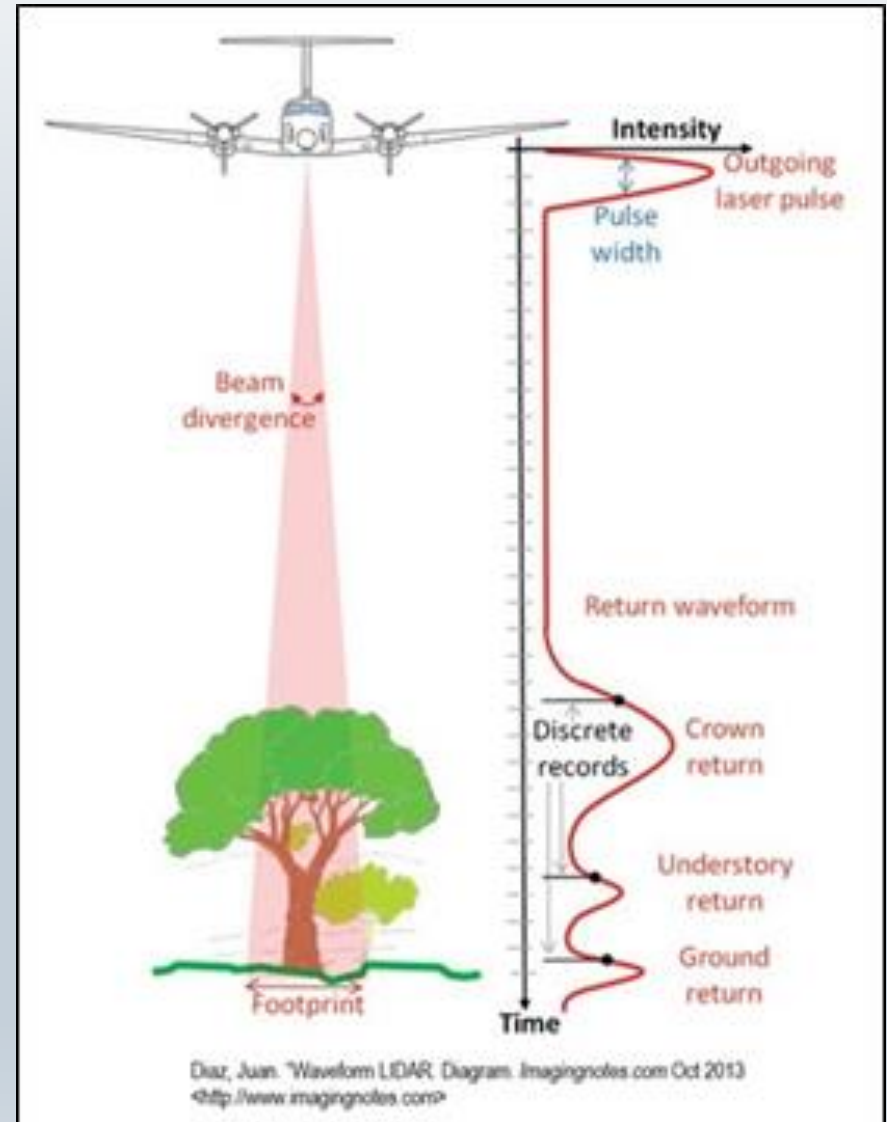
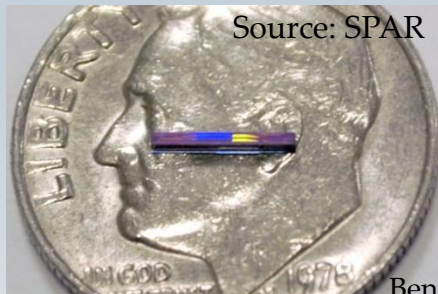
GeoSLAM ZEB
Horizon Promo (YT)



Imaging PL: Lidar (Point Clouds)

Important Considerations:

- Similar to pushbroom hyperspectral, needs quality INS to georef PC
- Number of returns/pulse is important for veg. areas
- Range → low-end designed for cars (>100m)
- Future improvements:



<https://support.geocue.com/waveform-data-terrascan/>

Imaging PL: Sensor Fusion

Examples:

- GeoCue - True View



Source: Geocue



Dual Cameras

Two GeoCue Mapping Cameras provide a 120° field of view, coincident with the laser scanner track. The 25° oblique mounting ensures the sides of objects are imaged, allowing a true 3D colorization of all LIDAR points.



LIDAR Scanner

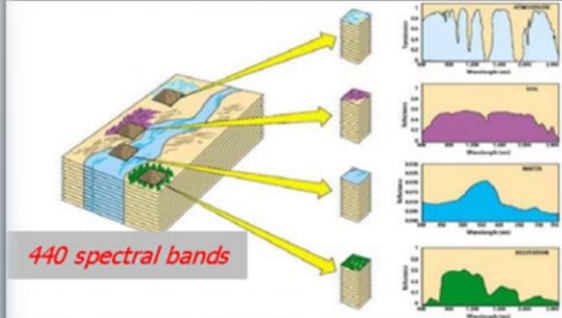
The Quanergy M8 Ultra scanner provides range of up to 100m with three returns per outgoing pulse.

Imaging PL: Sensor Fusion

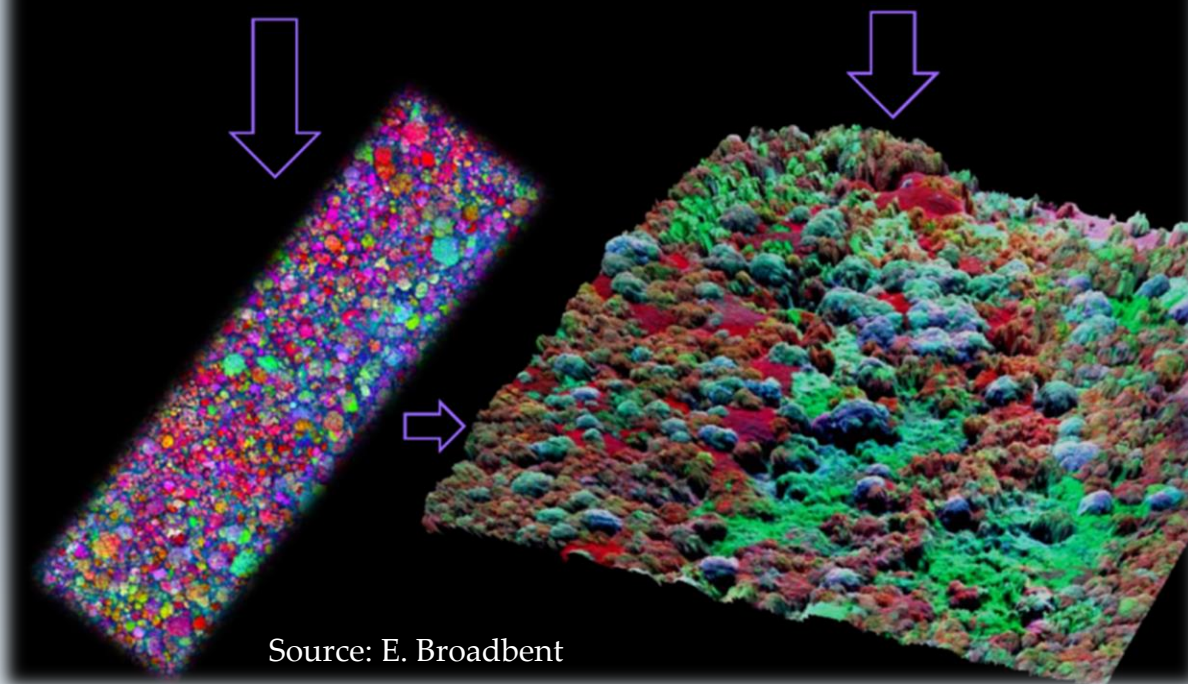
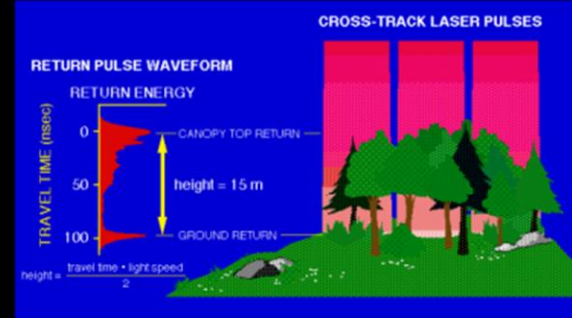
Examples:

- GatorEye – Unmanned Flying Laboratory

VSWIR Hi-fidelity Imaging Spectrometer



Multi-pulse Waveform LiDAR



Source: E. Broadbent

GatorEye
Unmanned Flying Laboratory



THANK YOU!

?s

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