

PHASE**ONE**  
IMAGING BEYOND IMAGINATION

# Phase One Ultra-high resolution Cameras in Precision Agriculture

Dejan Dragic  
DroneEdge, 2021

# Phase One Cameras – Workflow - Benefits

## Short summary

- In phenotyping field, researchers want accurate counts of plants or plant organs for emergence/yield estimation
- Traditionally requires labour and time intensive manual counting
- Advances in computing power/computer vision theory makes object detection possible using drone imagery
- Best results with high resolution imagery which retain small-scale object details
  - But can't fly too close or drone may affect trials
- High megapixels = high object detail without having to fly dangerously close
  - 1mm resolution with Phase One versus 5mm to safely fly with standard RGB drone camera to prevent alignment issues
  - Despite high resolution, wide area covered
    - Background features retained between images, useful for alignment
    - Avoid other risks involved with high resolution (e.g. timing issues due to large amounts of images needed)
- Image quality high
  - Contrast between target wheat ears and background leaves is strong. Model performance can decrease when this is not the case
- Purpose of object detection workflow is to:
  - simplify the process for end users
  - Leverage high amounts of data
    - Otherwise, extra time required to annotate and train per site

# Phase One Metric Aerial Cameras

## iXM-100 – 100MP Camera



Ultra fast and large  
internal storage



Improved light sensitivity  
for low light conditions



Fast Capture Rate 3FPS



Wide dynamic range

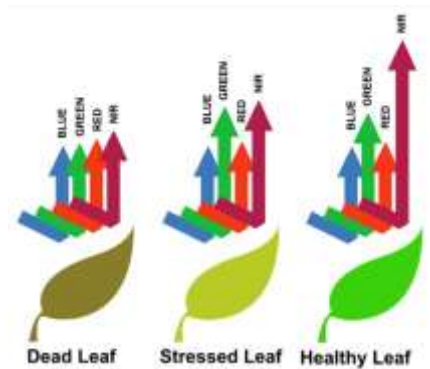


Reliable shutter  
min. 500.000 captures



Motion Blur Compensation  
by BCT

# Phase One 4-band Solution



RGB image



NIR image



CIR image



NDVI image

Camera Calibration

Cameras

Controller

Software



# Phase One Metric Aerial Cameras

## iXM-100

Example with 1mm GSD

21m AGL

Area coverage on ground = 12 x 9 m

Phase One iXM-100 (101MP)

Focal length 80mm, (equivalent to Full Frame 35mm = 63mm)

Sensor Size 43,9mm x 32,9mm, Pixel Size 3,76µm

11664 x 8750px



# Phase One Metric Aerial Cameras

## iXM-100

Example with 6mm GSD  
56m AGL  
Area coverage on ground = 70 x 53 m

Phase One iXM-100 (101MP)  
Focal length 35mm, (equivalent to Full Frame 35mm = 27mm)  
Sensor Size 43,9mm x 32,9mm, Pixel Size 3,76µm  
11664 x 8750 px



# Phase One Metric Aerial Cameras

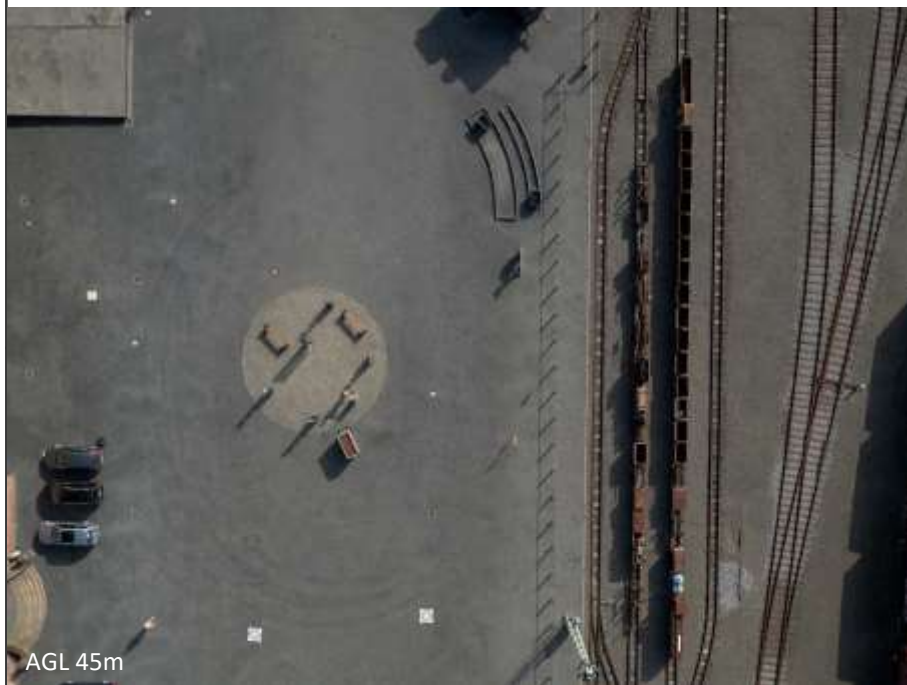
## iXM-100

### DJI Phantom 4 Pro (20MP)

Focal length 8mm, (equivalent to Full Frame 35mm = 21,6mm)

Sensor Size 13,2mm x 8,8mm, Pixel Size 2,4µm

5472 x 3648 px



AGL 45m

### Phase One iXM-100 (101MP)

Focal length 35mm, (equivalent to Full Frame 35mm = 27mm)

Sensor Size 43,9mm x 32,9mm, Pixel Size 3,76µm

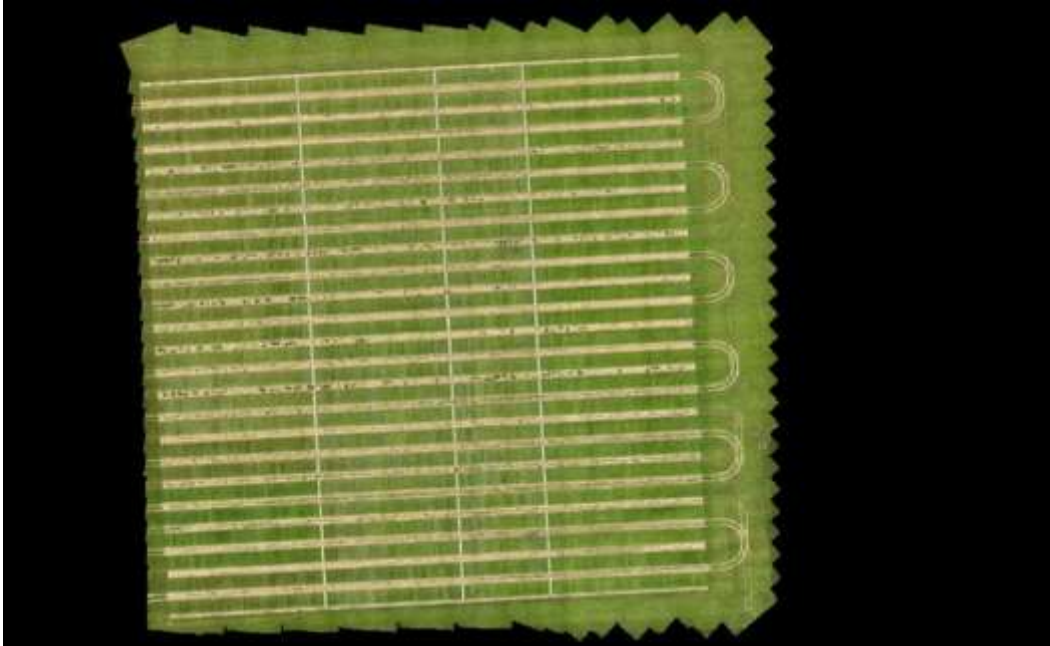
11664 x 8750 px



AGL 126m

# Precision Application use case

## Plot-Based Trait Assessment



Close-up zoom of vegetation for digital phenotyping USASK 2019 ©



# Precision Application use case

## Drone-Based Ear Counting

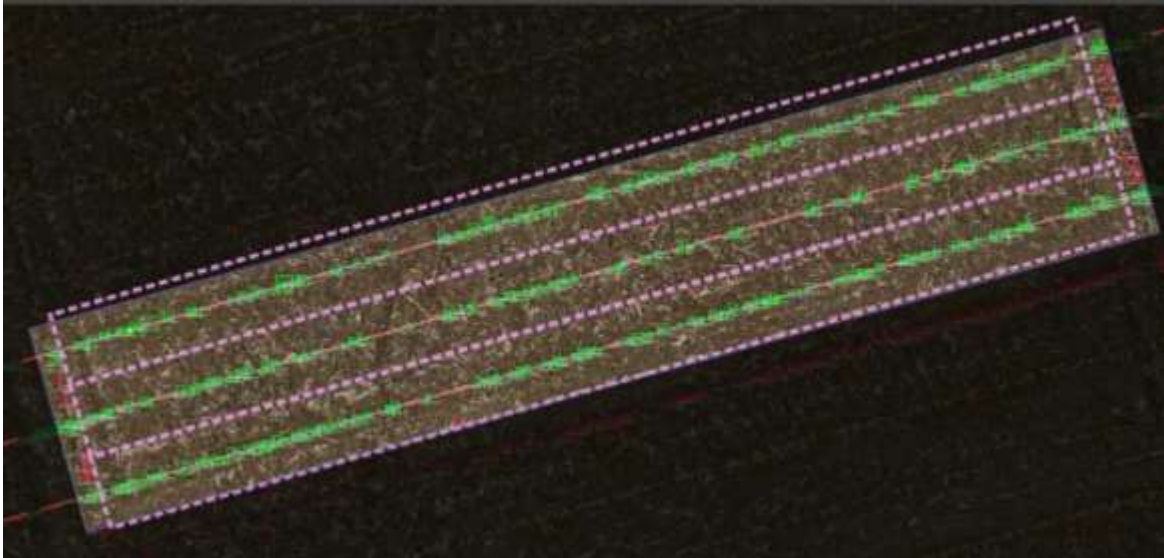


Faster, more precise, and cheaper than by humans



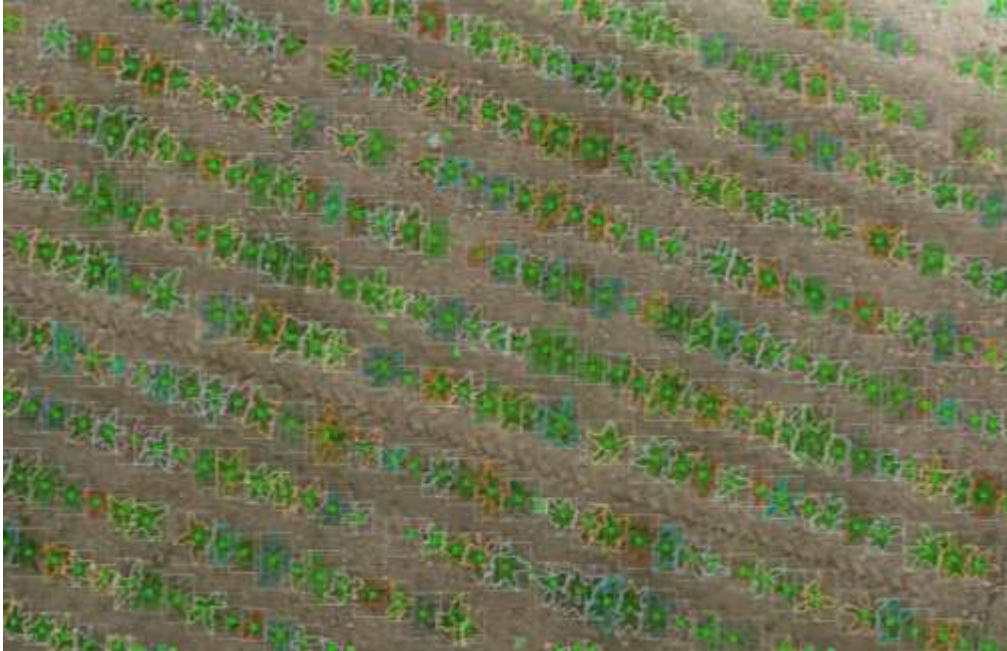
# Precision Application use case

## Trait Assessment in Sugar Beet

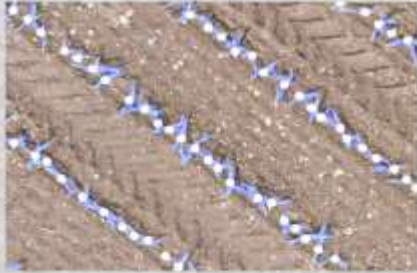


# Precision Application use case

## Trait Assessment in Sugar Beet



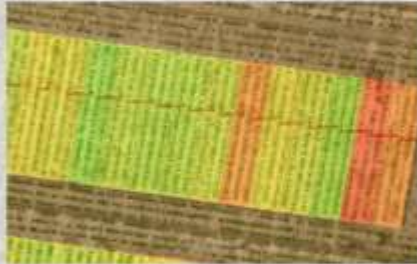
# Special use cases for high resolution imagery



Counting  
Sizing



Semantic  
Maps



Homogeneity  
Assesment



Stress  
Disease



Weed  
Monitoring



Individual  
Objects





# Applications: Wheat Phenotyping – early growth

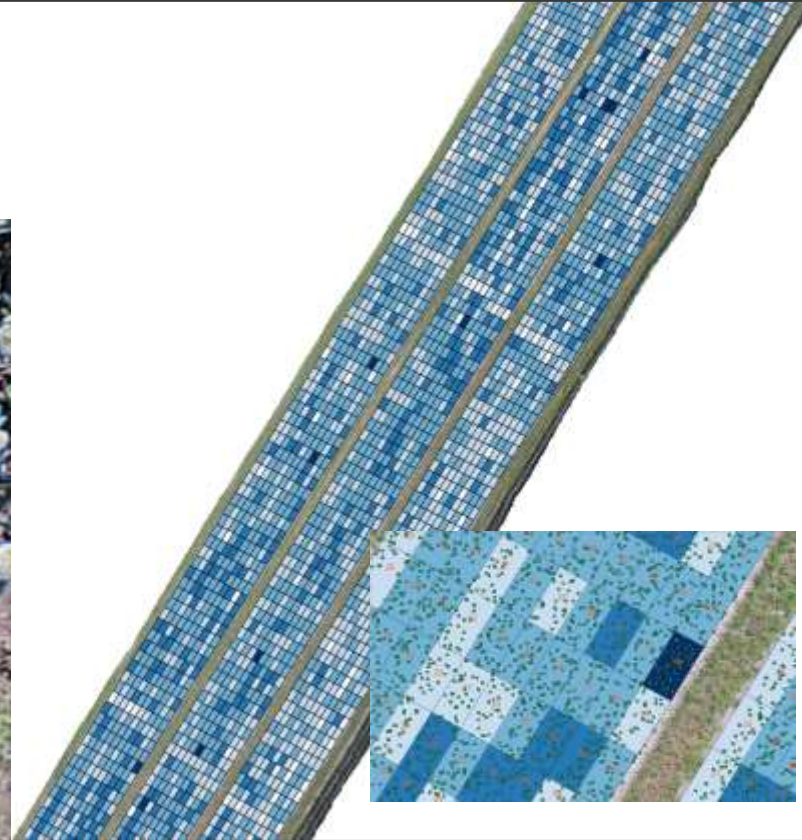
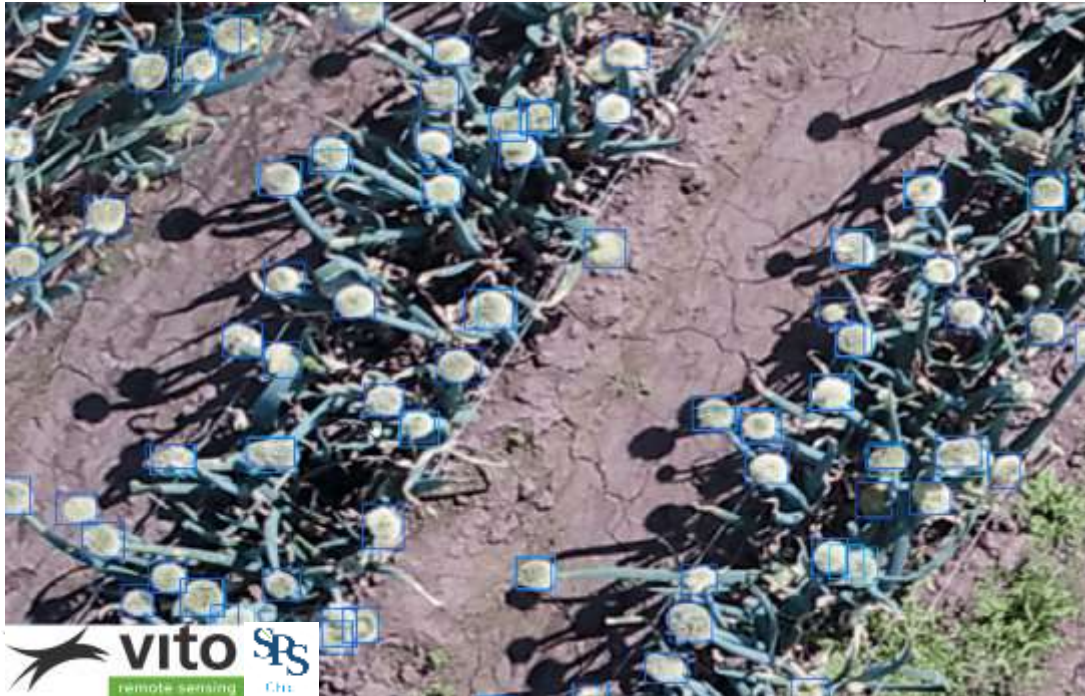




# Applications – Onion Flower Count

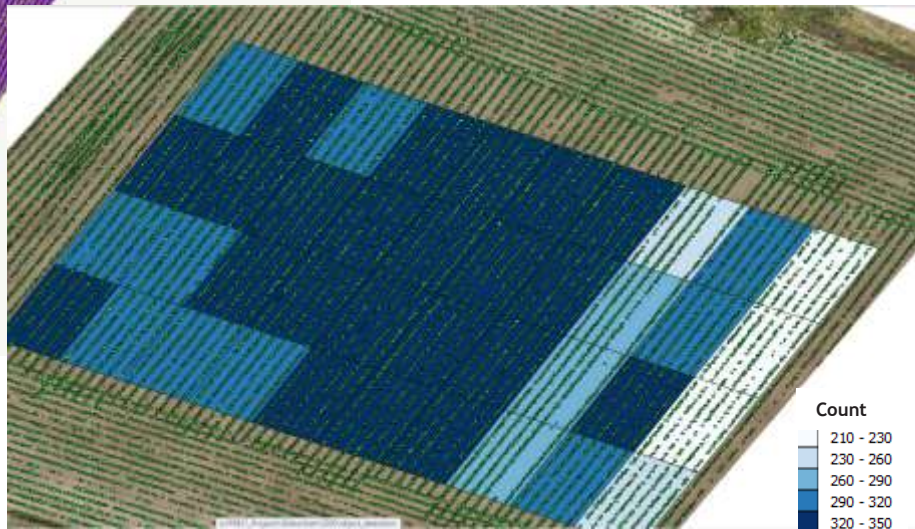
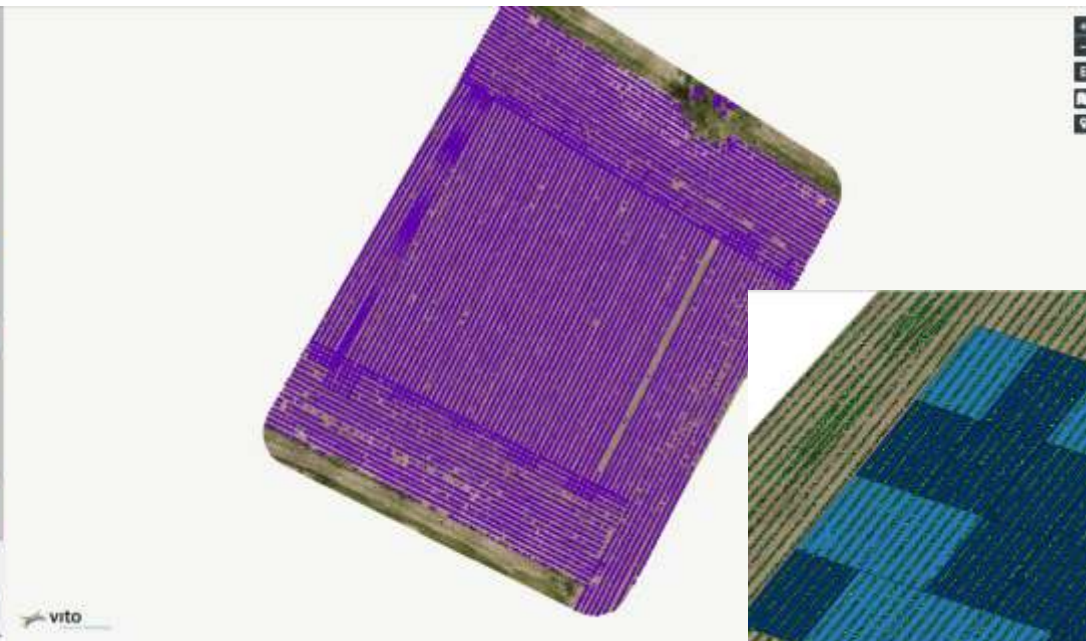
Onion flower counting using computer vision

- Regions of low seed quantity
- Optimal harvest time





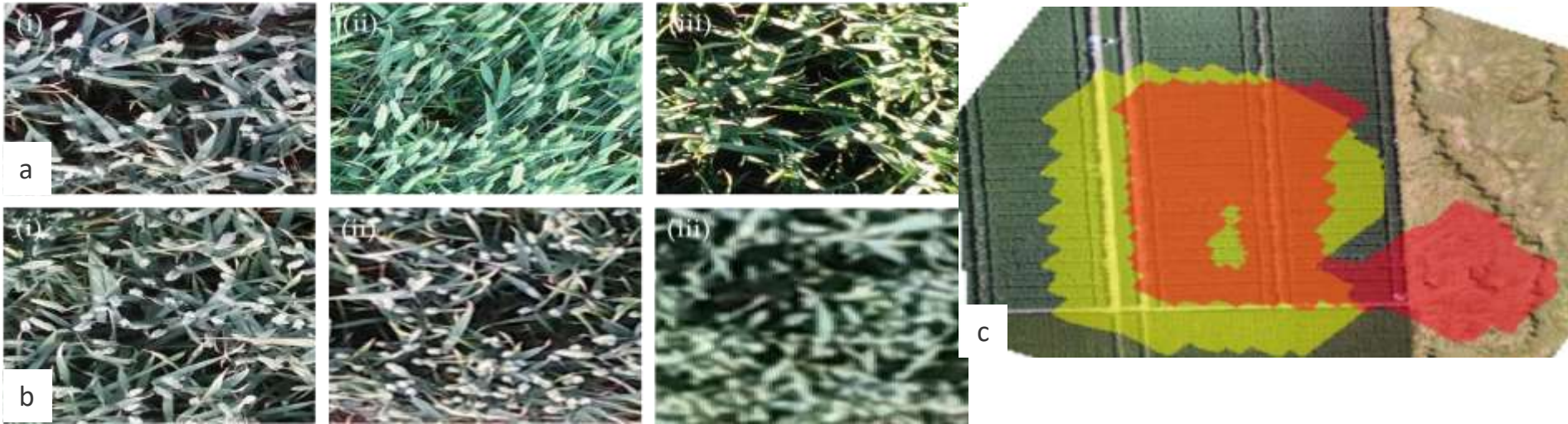
# Applications – Plant Emergence





# Resolution vs. Coverage Challenge

- 2019 Wheat Head detection tests of different flight heights and resolutions, various cameras.
- Camera affects quality, resolution affects coverage



(a) Comparison of drone camera image quality (1mm/pixel) for the (i) Zenmuse X5S, (ii) Phantom 4 Pro, and (iii) Mavic 2 Pro; (b) Comparison of image quality for the orthomosaics produced with images from the Zenmuse X5S, with ground resolutions of (i) 0.99mm, (ii) 2.14mm, and (iii) 4.99mm; (c) Coverage of orthomosaics after alignment for the Zenmuse X5S, showing overall alignment coverage achieved for the 5mm ground resolution images (RGB), 2mm images (yellow overlay), and 1mm images (red overlay).



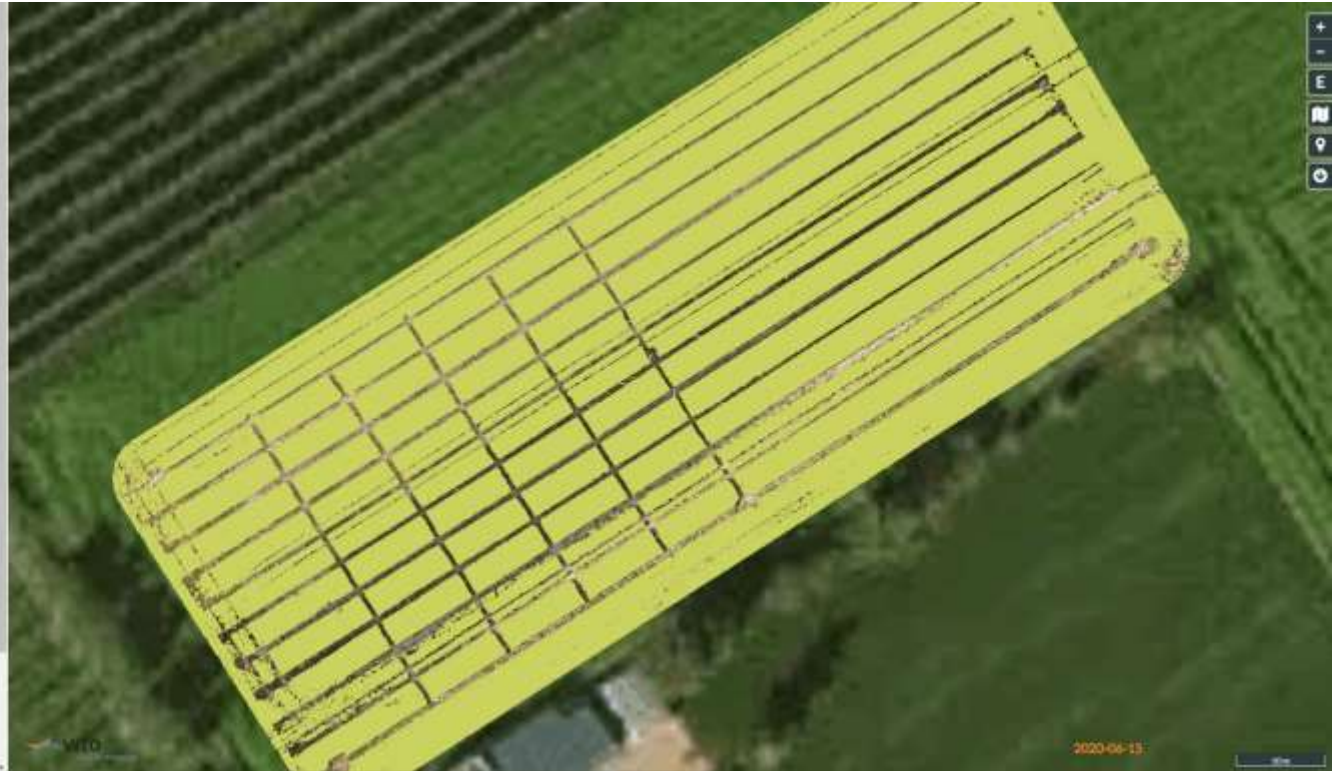
# Object Detection: Phase One Camera

- Overcomes common data issues for very high resolutions:
  - Flies high enough to not affect fields
  - Covers larger spatial extent, easier image alignment.
  - Faster completion of Flights
  - Sharp imagery





# Results of wheat head detection



Connect and talk about your projects and Phase **One**



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