

# Hexagon Hybrid Airborne Sensors

Precise, Productive, Flexible  
Lidar and Images, best of both technologies

Klaus Neumann  
VP Sales Airborne Solutions



# Airborne sensor portfolio – Sensor solutions for a variety of applications



# Leica CityMapper2 System Overview

## PAV200 Mount

- Stabilises the sensor for flight path deviations in roll, pitch and yaw
- Minimises image blur and improves LiDAR data distribution

## Pod Lifter

- Makes operation easy in low aircrafts

## LiDAR & Camera Controller

- Built in

## OC61 Operator Console

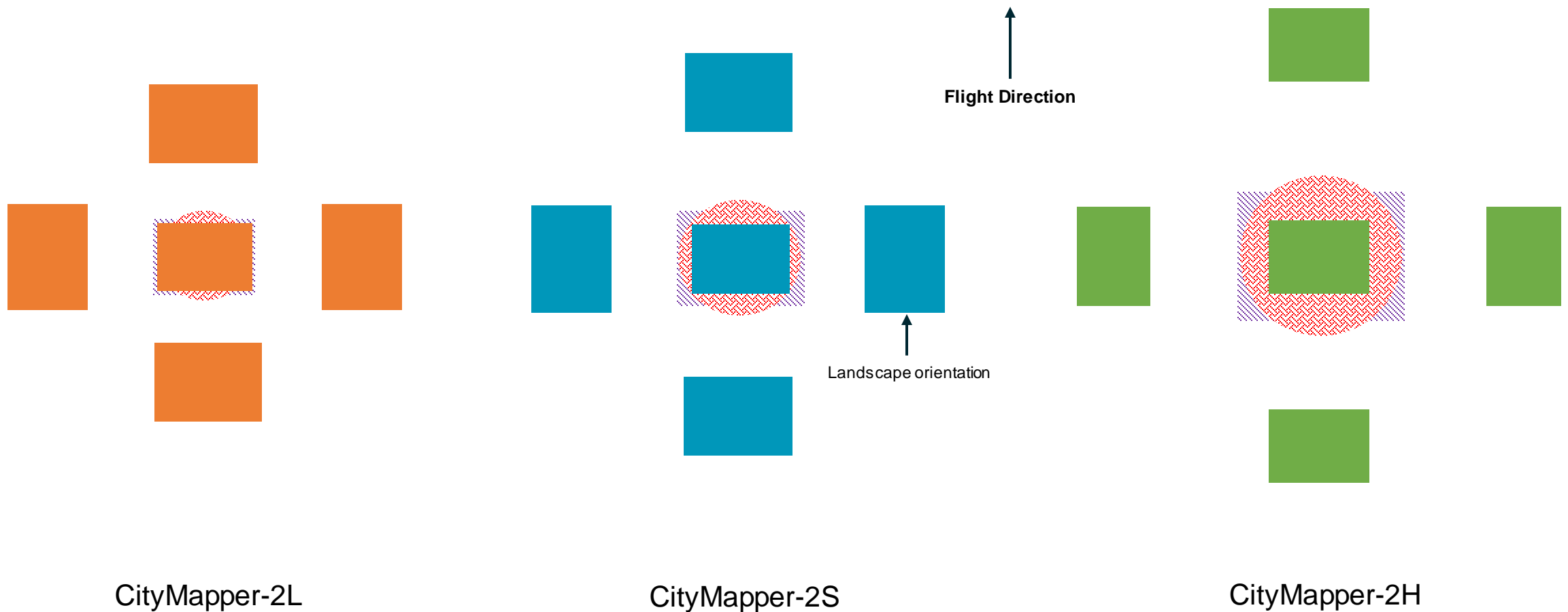
- 12.1" screen hosting the Sensor Operator interface

## PD61 Pilot Display

- 6.3" screen hosting the Pilot Interface



# CityMapper2 Sensor Orientation



# CityMapper2 includes a full version of TerrainMapper

## Most efficient linear mode LiDAR

- Highest collection efficiency among all linear mode LiDAR, with up to 2 MHz
- Flying altitude from 300 m to > 5,000 m AGL

## All terrain

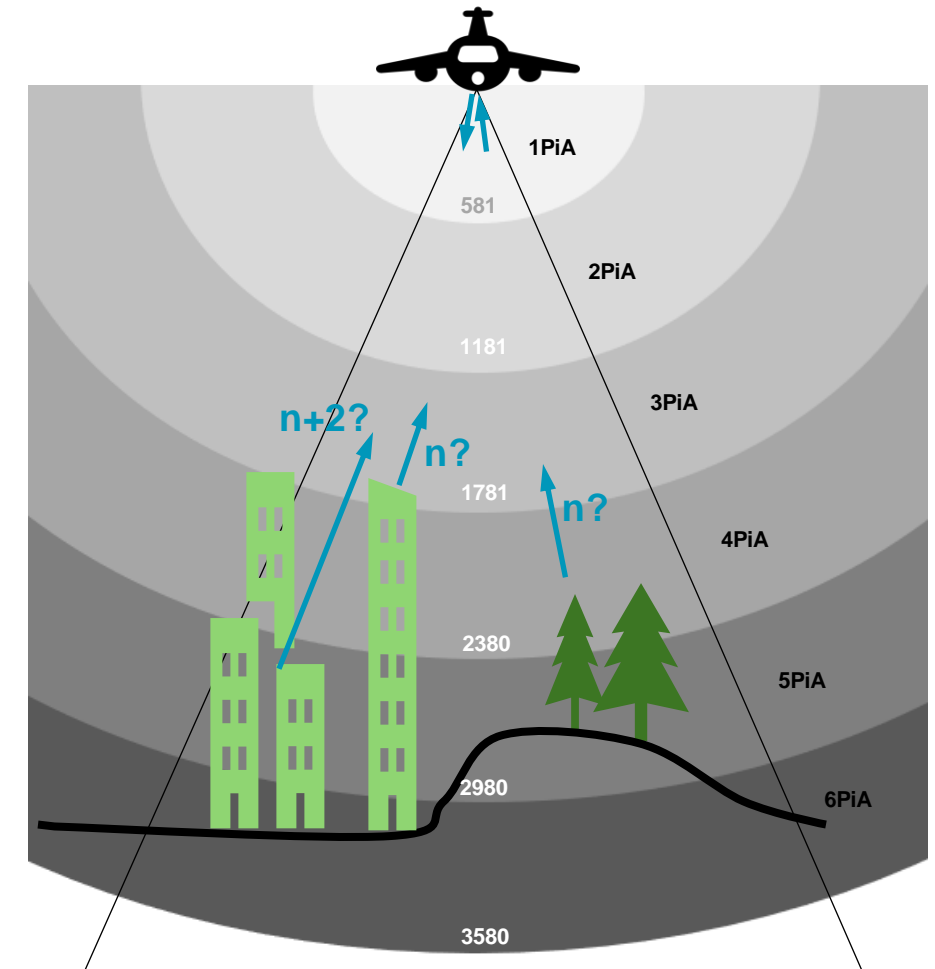
- Handles complex terrain, from urban mapping to mountainous area due to gateless MPiA zones
- Handles up to 35 LiDAR pulses in the air (MPiA zones) simultaneously

## Circular scan with even point density

- Circular pattern LiDAR scanning delivers full oblique coverage
- Even point density mode provides same point density at the center and at the FOV edges
- Adjustable field of view from 20 to 40 degrees enables extreme point densities
- Scanner speed of up to 7,500 RPM (250 scan lines per second) offers a good point distribution over a broad range of flying heights and aircraft speeds

## Full waveform LiDAR

- Full waveform LiDAR system with on-board real-time waveform-to-range processing
- Capable of extracting of up to 15 returns per outbound LiDAR pulse, with a minimum return separation of less than 30 cm



Function of gateless MPiA zone technology

# Leica CountryMapper System Overview

## Leica Large-format Frame Solution

- Only manufacturer with CMOS + FMC
- Unmatched 4-band, 31,520 cross-track pixel count
- Fast 0.7-second frame interval for forward overlap and aircraft speed freedom

## New LiDAR Unit

- Expanded 10-60 degrees FOV range for side-overlap flexibility
- Increased 166 Hz max scan rate
- Improved lidar divergence

**New System Controller Module**, upper pod with faster data logging, faster/larger-capacity storage for hybrid mission flexibility

- OC61/PD61 common to CityMapper-2, TerrainMapper-2, DMC-4



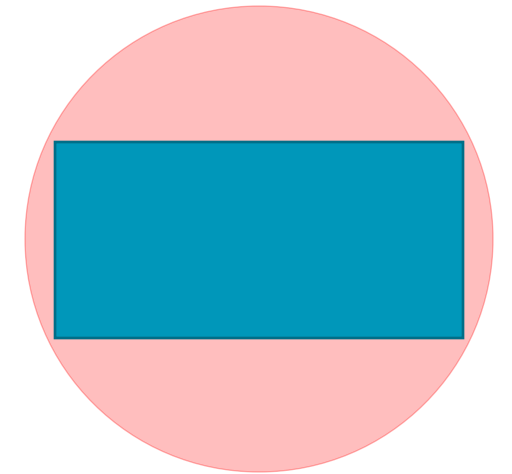
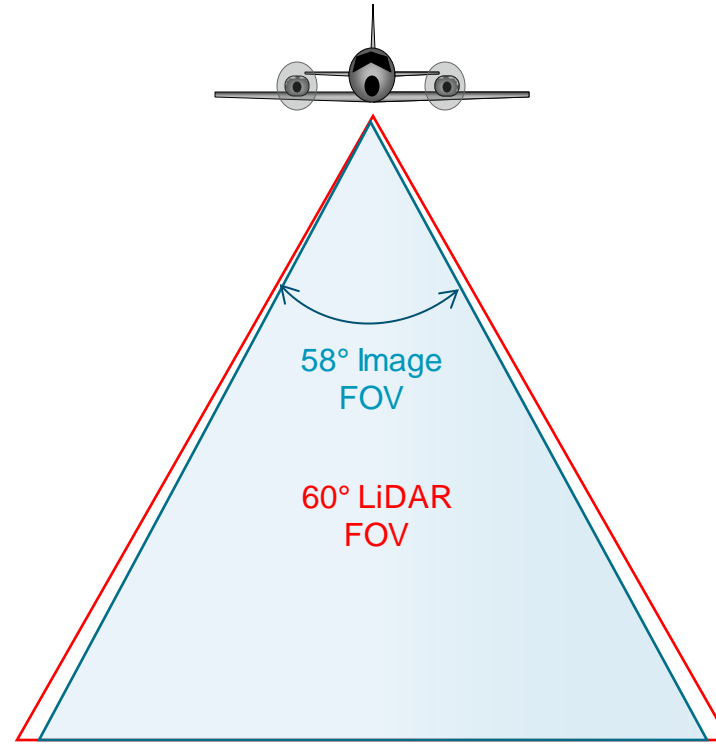
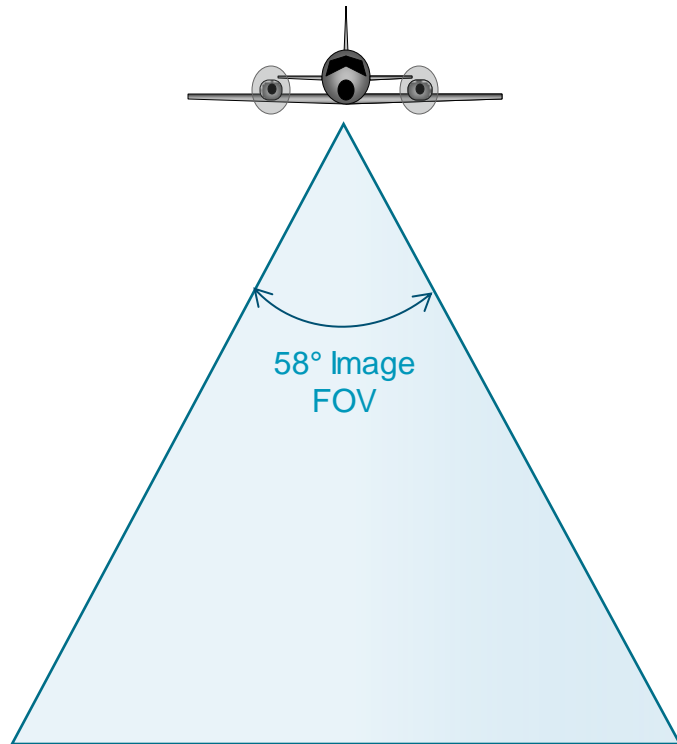
# Alignment of Leica DMC-4 and Leica CountryMapper S, H and W Options

Leica DMC -4			
Variant	S	H	W
Image FOV	58°	45°	66.2°

Leica CountryMapper			
Variant	S	H	W
Image FOV	58°	45°	66.2°
LiDAR FOV	60°	60°	60°

New LiDAR!

# Leica DMC-4S + LiDAR = Leica CountryMapper S





# Co-collect Envelope for Leica CountryMapper



Imagery at 10-20cm GSD

5 - 10cm GSD requirements are becoming more common  
Co-collection of high-resolution imagery and regional density LiDAR data in a single pass = **Leica CountryMapper**  
LiDAR ranges increasing for 2-8 points/m<sup>2</sup>

LiDAR at 2-20 points/m<sup>2</sup>

# Imaging + LiDAR = nearly infinite applications

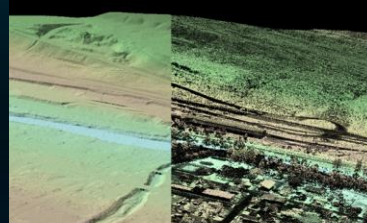
Carbon Capture



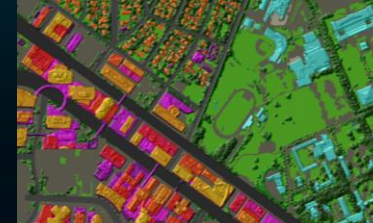
Airspace Intrusion



Flood Zone Maps



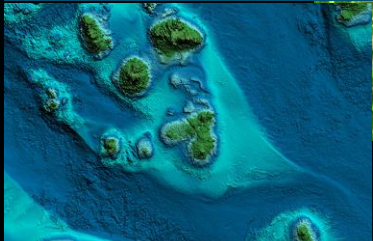
Telecom



Forest Inventory



Bathymetry



National Mapping



Regional Mapping



Orthophotography



Feature Extraction



Remote Sensing



Power Lines



Roads



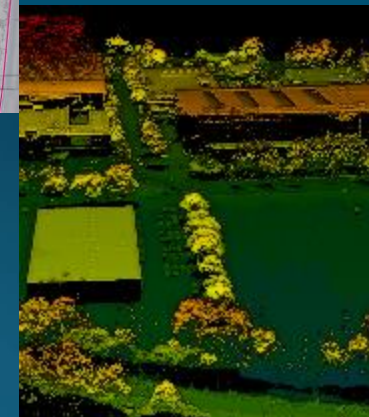
Rail



Cities



DSM/DEM







Announcing the  
**Leica  
TerrainMapper-3**



# Key, new LiDAR Capabilities in Leica CountryMapper

- **60° Field of View**  
→ improved area coverage rates
- **Laser divergence reduction**  
→ improved planimetric accuracy, better foliage penetration, improved area coverage rates when maximum laser footprint is limited by contract
- **New scanning pattern**  
→ ellipse and skew ellipse scanning pattern



# Leica TerrainMapper-3

Supporting the widest variety of applications in a single system

- **High-performance 2 MHz LiDAR with an expanded 60-degrees adjustable field of view** allows users to collect more data with fewer flight lines
- **Reduced laser divergence** enables greater accuracy, especially for small objects like power lines and building edges
- **Higher scan speeds** for TerrainMapper-3 enable users to fly faster while collecting high-quality data
- **Circle, Ellipse and Skew Ellipse** configurations for wide-area mapping, steep terrain and urban canyons, vegetation studies, as well as power and infrastructure corridors
- **New waveform capabilities**
  - ✓ **Waveform attributes** offering new opportunities for advanced and automated point classification
  - ✓ **Full waveform recording at max PRF**
- **Steep Terrain Mode**-flight planning and processing option which allow for enhanced MPiA zone resolution in areas of significant elevation change





# New Scan Combinations to Address a Wider Variant of Applications



Circle Scan



Ellipse Scan



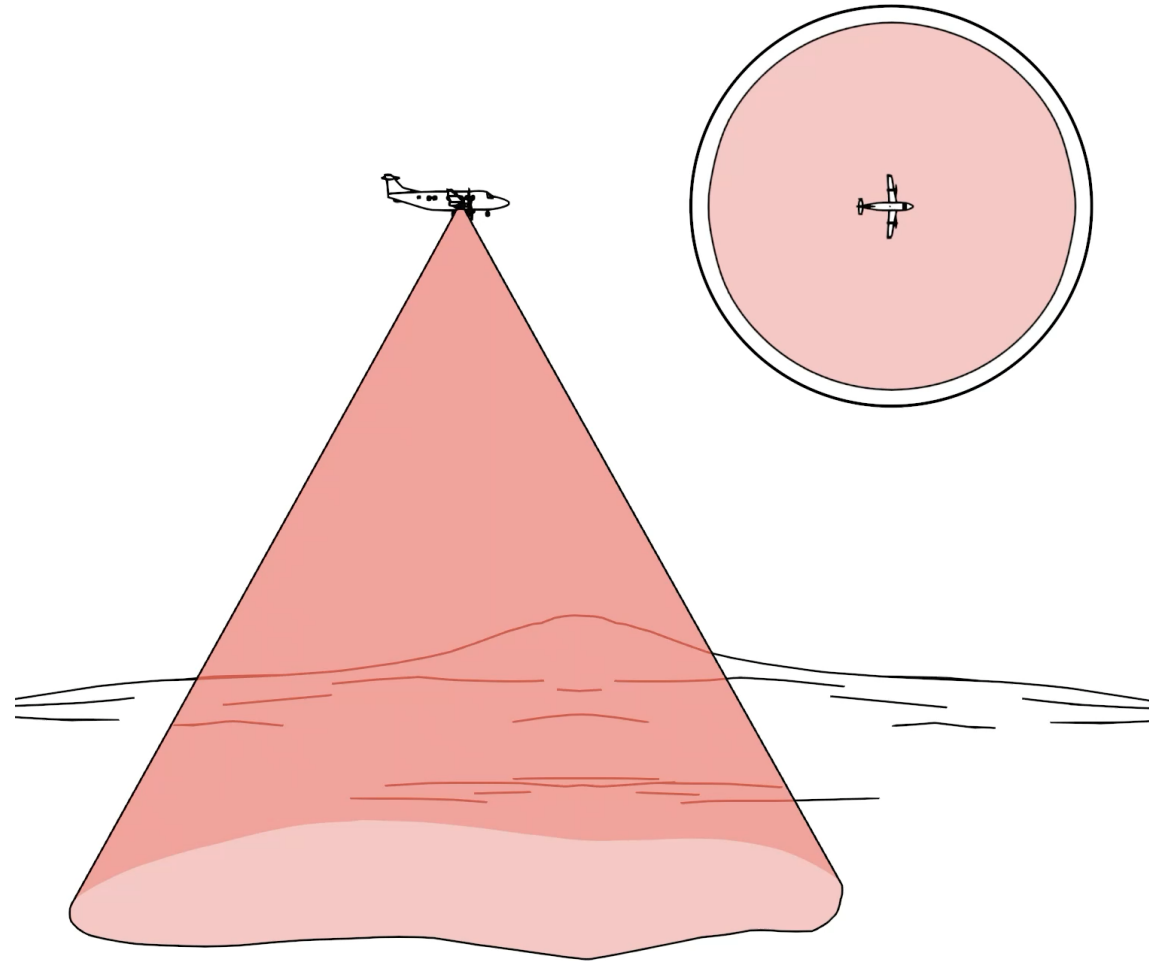
Skew Ellipse Scan

# Leica TerrainMapper-3

## Circle scan option

### Traditional Hyperion scan

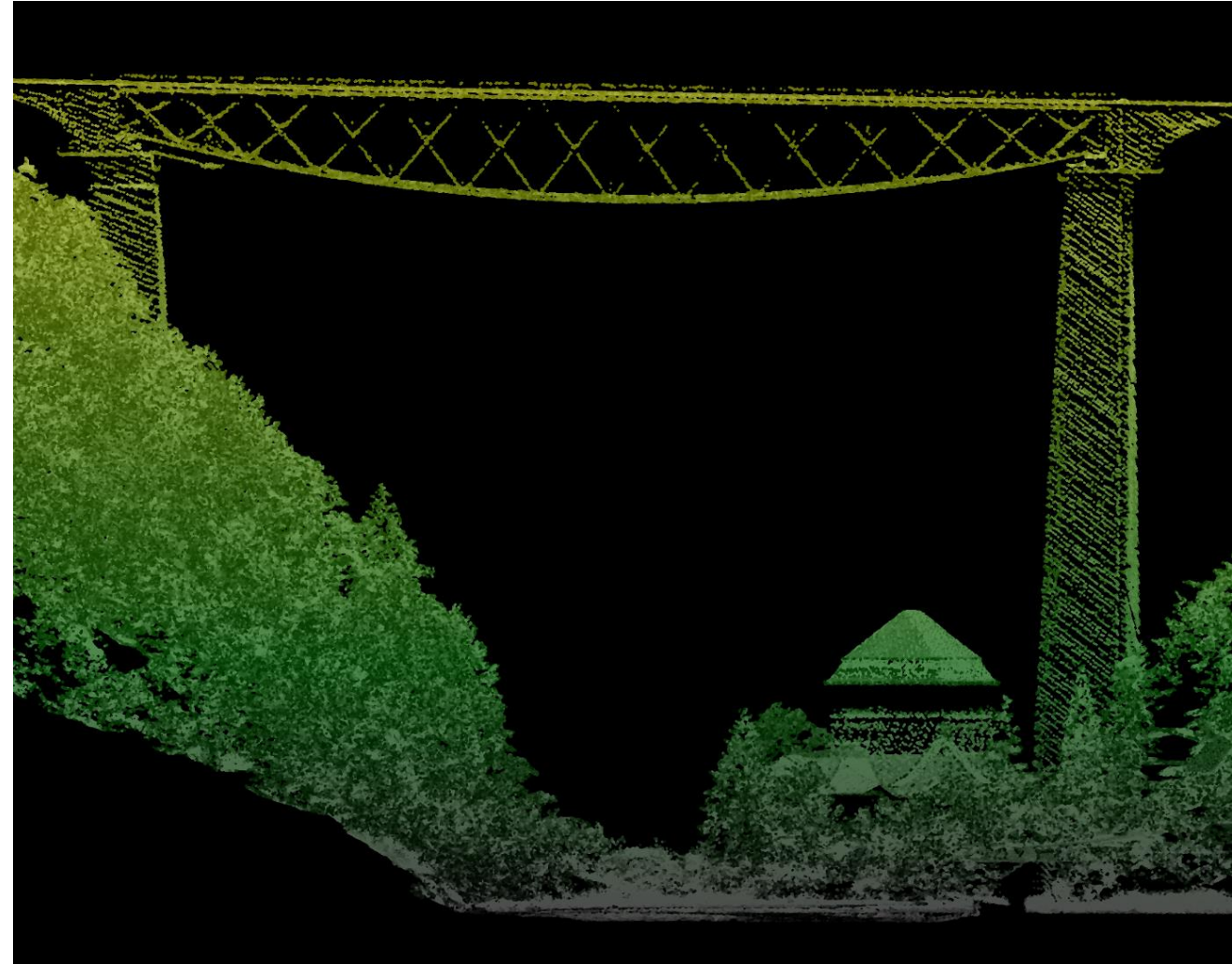
- Configurable for 10° to 60° field of view suited for 3D modelling of lower-density urban areas or steep terrain
- Excellent pattern for modelling vertical infrastructure and vegetation especially in steep terrain



# Hyperion2+ LiDAR Unit with Circular Scan

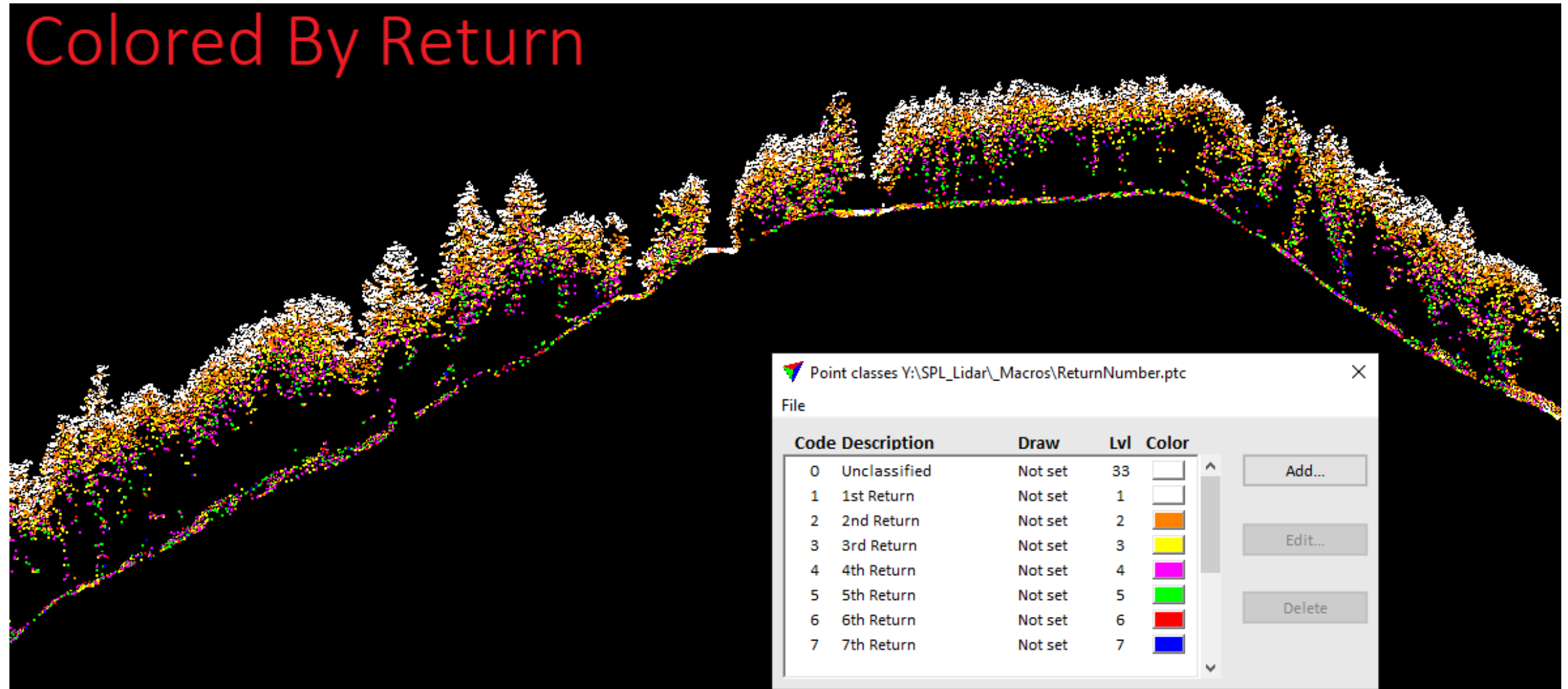
## Benefits of circular scan

- Conical scan pattern delivers full oblique coverage for enhanced detail on vertical surfaces
- Reduced number of MPiA zones encountered compared to planar scanning patterns
- Even point density mode provides same point density at swath center and edges
- Adjustable field of view from 10 to 60 degrees enables extreme point densities
- High scanner speed (up to 333 scan lines per second) offers small along-track spacing over a broad range of aircraft speeds



# Foliage Penetration Even in Hilly Areas

2.5-meter-thick section shows extent of multiple returns

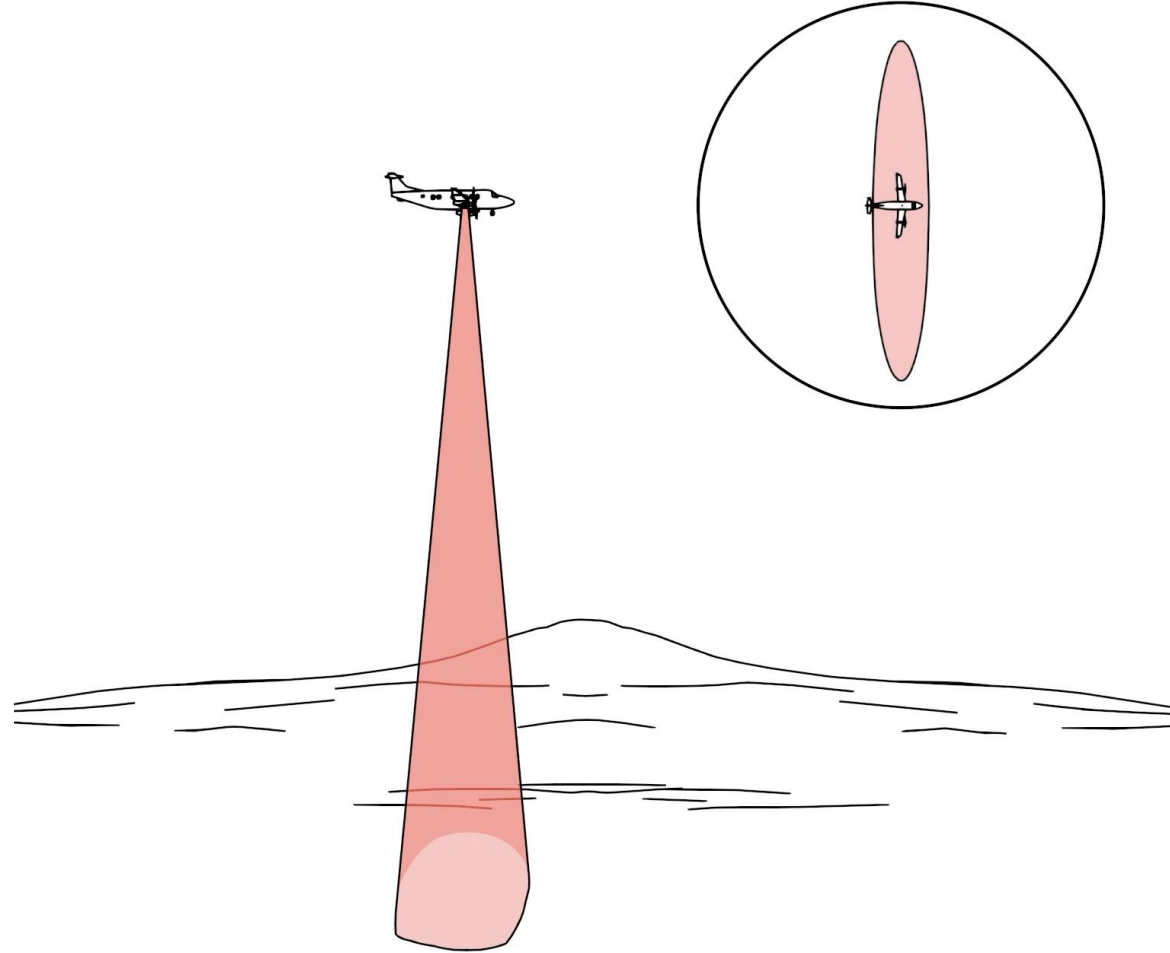


# Leica TerrainMapper-3

## Ellipse Scan option

### New, exclusive scan option!

- 10° **by** 60° field of view
- Excellent pattern for collecting urban canyons
- Well-suited for collecting in tall grass or crops
- Strong water surface returns for hydro-flattening or extracting land/water transition line
- Foliage penetration in flat terrain and/or ground points in dense, leaf-off vegetation





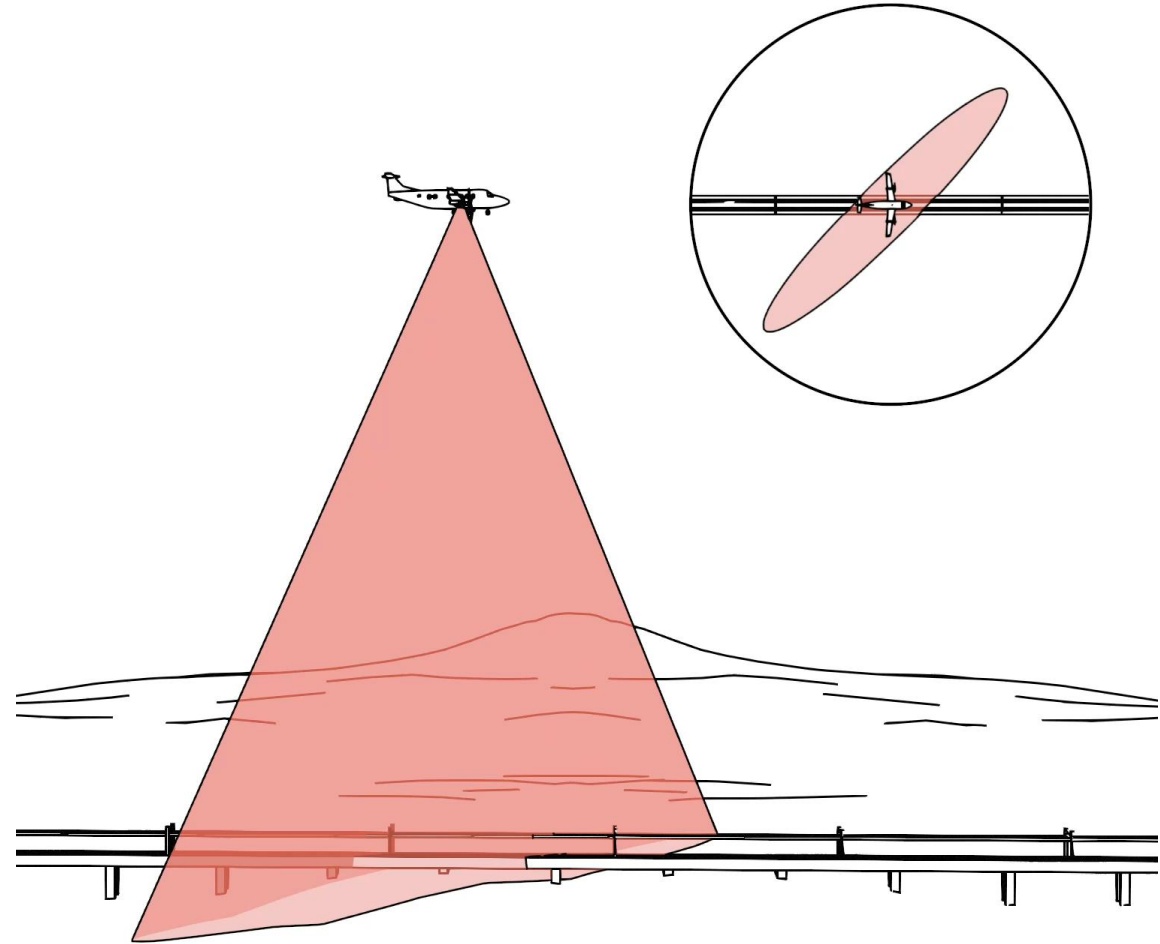
# Leica TerrainMapper-3

## Skew Ellipse Scan option

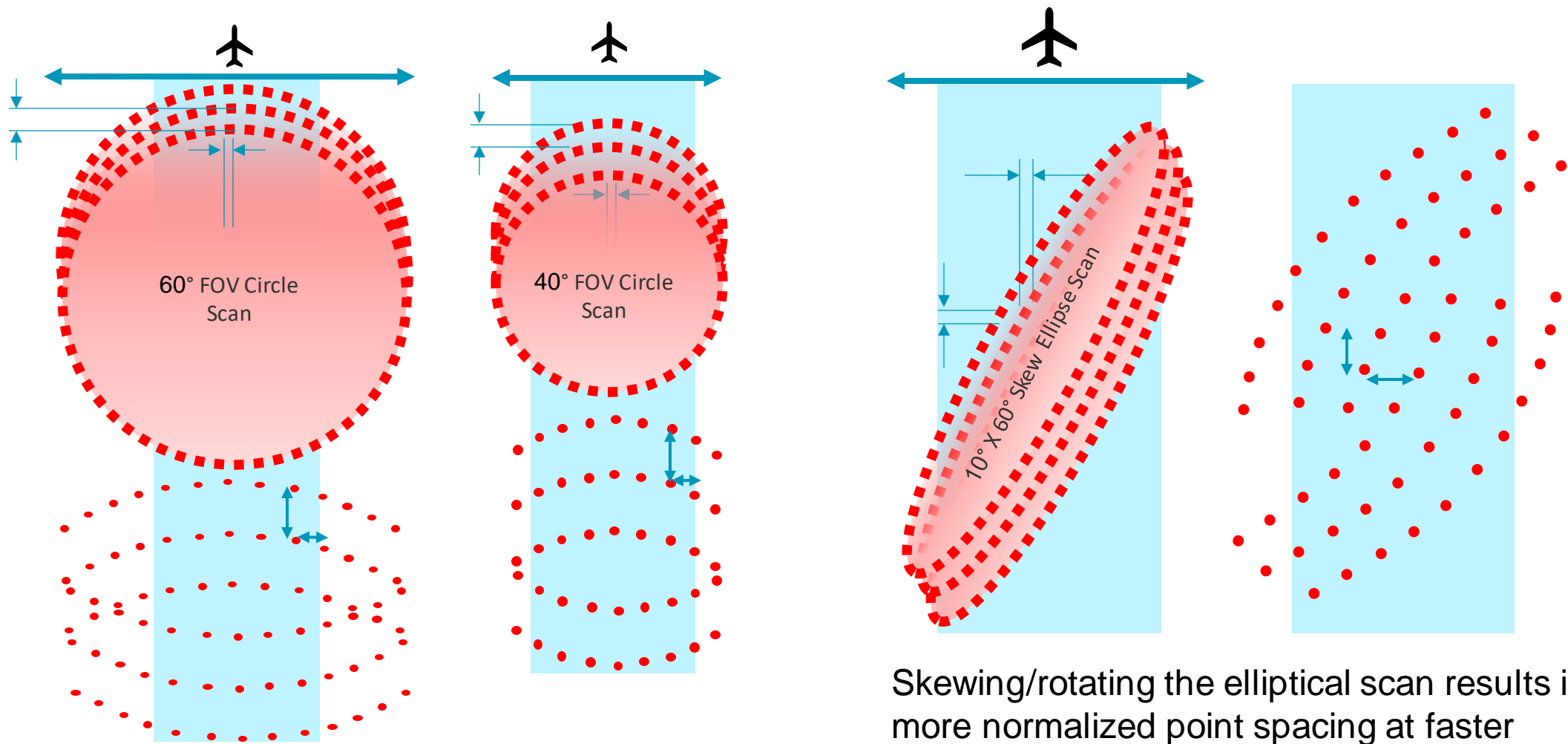
**New, exclusive scan option!**

**Ideally suited to corridor applications**

- 10° by 60° skewed or rotated scan
- Skew angle is adjustable from perpendicular to flight, to parallel to flight
- Excellent wire and rail returns w/ near-nadir points
- **Balanced along-track/cross-track point spacing** for reliable extraction of linear features



# Corridor Application of Skew Scan Pattern

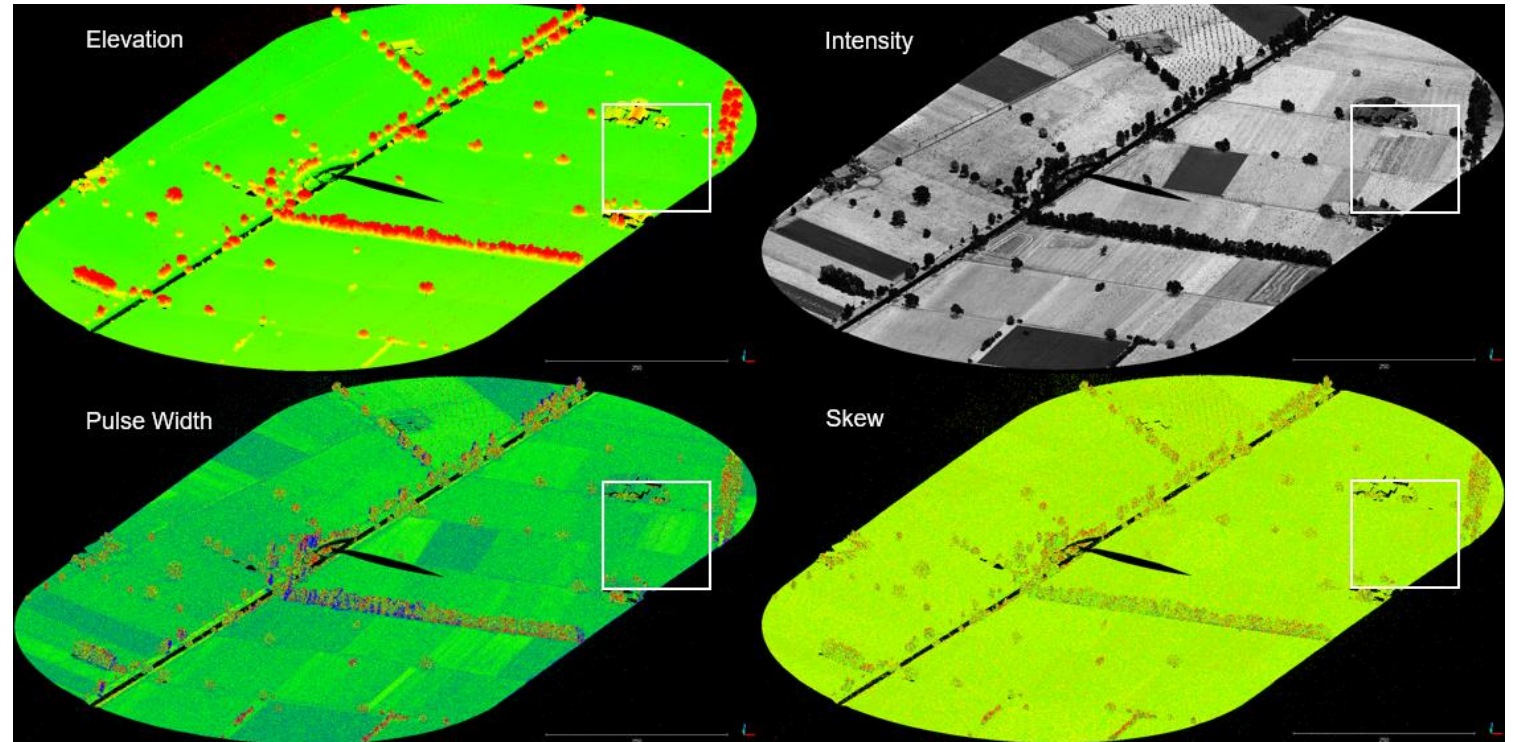


Skewing/rotating the elliptical scan results in more normalized point spacing at faster airspeeds

# Waveform Attributes

## Waveform analysis without waveform heft

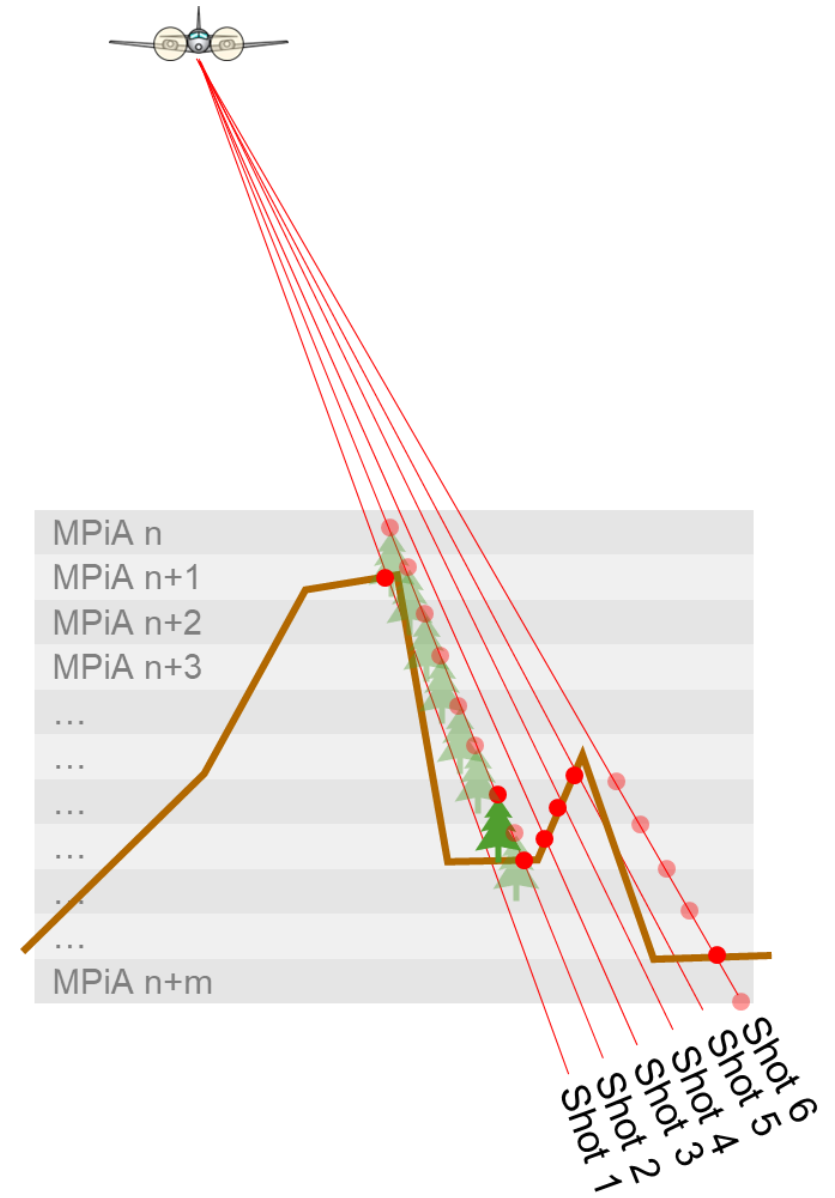
- **Pulse width, skew, amplitude and reflectance, examples of ExtraByte information for LAS output**
- Attributes have the potential to help refine classical classifications
- More interestingly, attributes may help train sophisticated AI-based classifiers



# Steep Terrain Mode

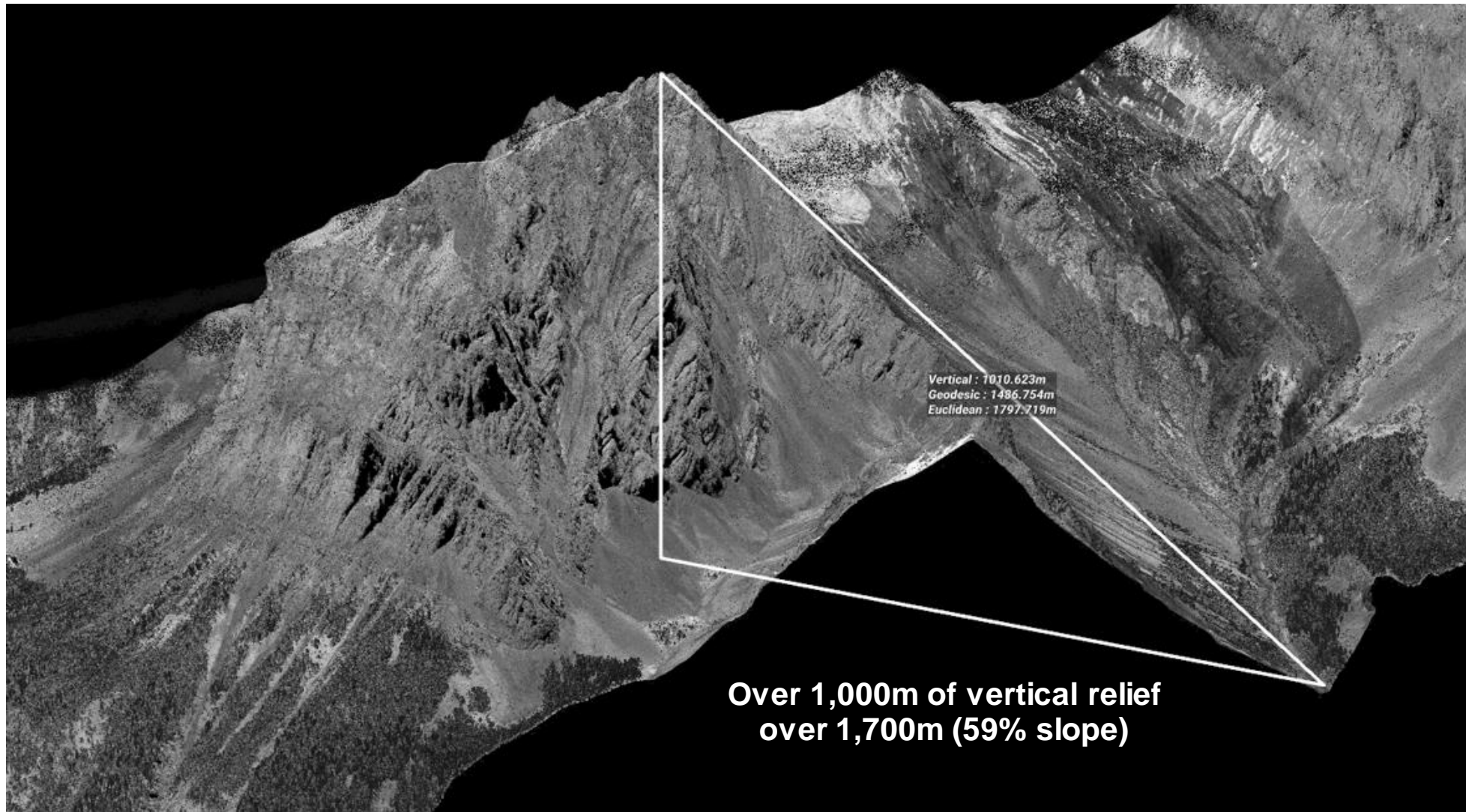
Steep Terrain Mode enhances MPiA ambiguity resolution

- Increases number of “test fits”
- Resolves issues due to:
  - Highly irregular and/or steep terrain
  - Cliffs
  - Steep, vegetated terrain
  - Sudden discontinuities in urban environments (e.g., at tops of skyscrapers)
- Drawbacks
  - Some reduction in maximum PRF
  - Some increase in processing time
- Best applied
  - In very steep/irregular/cliff terrain, especially with vegetation
  - In tall urban areas, where sudden severe elevation discontinuities exist





# Steep Terrain Mode





# Leica TerrainMapper-3

Supporting the widest variety of applications in a single system

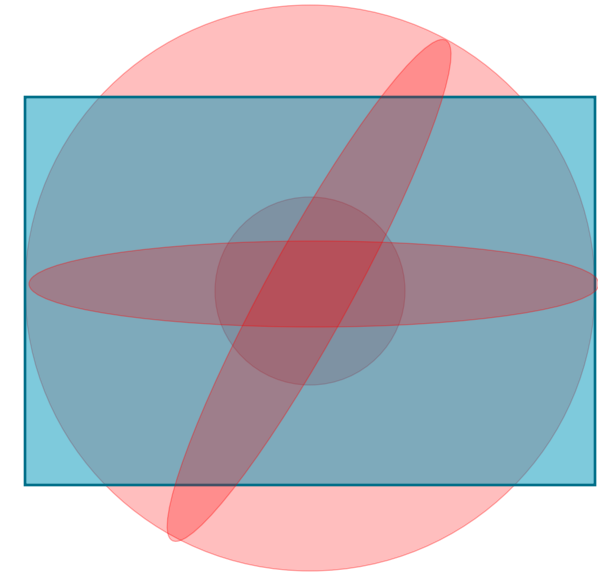
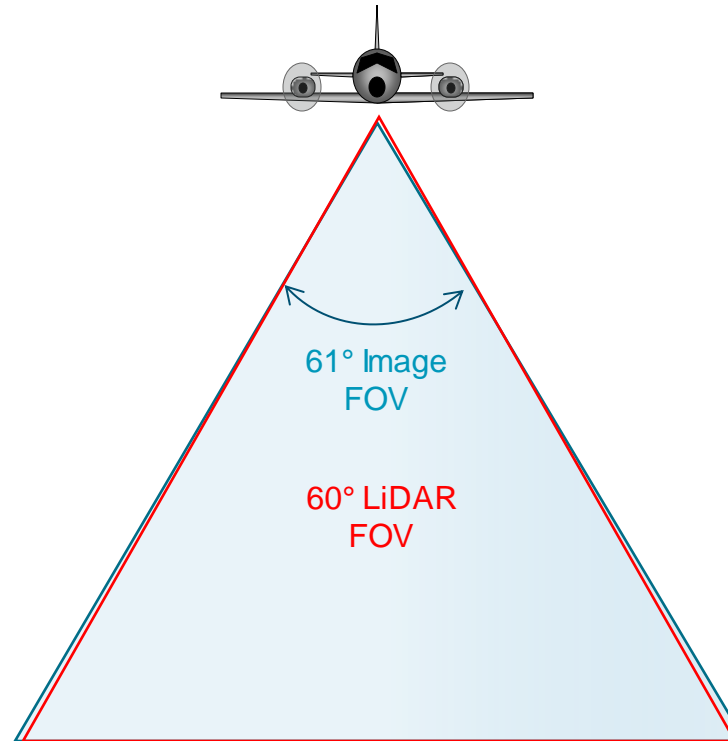
**MFC150-** 14,192 x 10,640 pixels  
RGBN (1:1)

## GSD Examples

- 5cm @ 600m AGL
- 10cm @ 1200m
- 20cm @ 2400m
- 40cm @ 4800m

## LiDAR Density Examples

Points/m2	FOV-60°	FOV-30°
16	797m AGL	1750m AGL
12	1073m	2375m
8	1624m	3100m
4	3050m	4150m
2	3900m	5300m
1	4950m	6000m



# TerrainMapper-3 System Overview

- Sensor Pod
  - Hyperion2+ LiDAR Unit
  - RGB & NIR MFC150 cameras
- Uses System Control Module, upper pod, all common to CityMapper-2
- Upper pod/electronics upgrade with integrated sensor control and logging
- PAV200
- OC61 & PD61 operator and pilot displays



# MFC150 Camera Modules

- MFC150: designed from the start for aerial imaging
- Sensor: 150 MP, 14,192 x 10,640 pixels (RGB, B/W for NIR)
  - Pixel size, type: 3.76  $\mu\text{m}$ , Back Side Illuminated (BSI) CMOS
  - Dynamic range: 83 dB
  - Resolution A/D converter: 14-bit
  - Frame interval: 0.8 sec
- Motion compensation: mechanical FMC for superb low-light performance
- Lenses: specially coated for RGB and NIR
- Operating temperature range: -10 to +35 C
- Shutter: maximum speed 1/1000 sec, up to 500,000 cycles



# Software for Image QC

## In-the-aircraft QC of images when flying

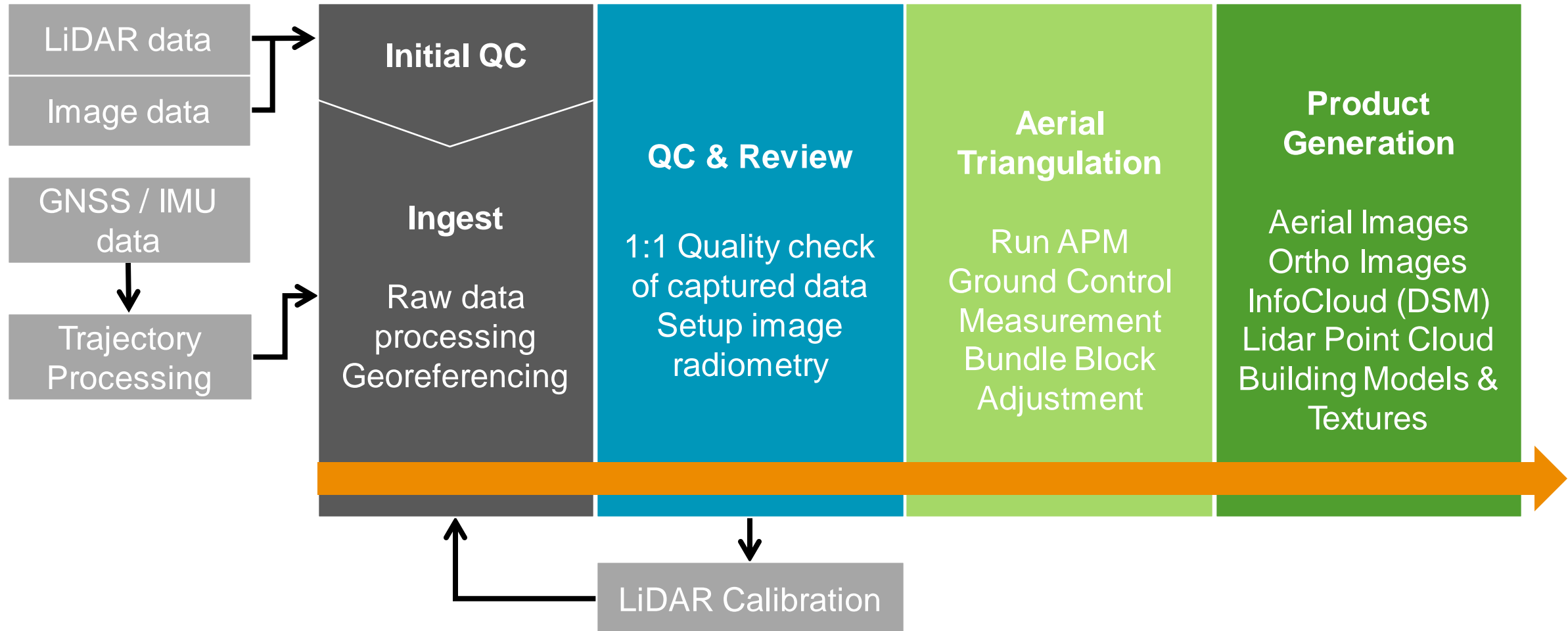
- RGB and NIR images from nadir cameras
- Single or multi-frame view
- Mark frames for re-flight
- Directly queue execution of re-flight (full line or affected parts of line)

## Off-line QC of images

- Thumbnails can be stored on USB during flight (resolution 3,536 x 2,656 pixels)
- Fast QC of images with third-party software
- Hand-over of QC information to MissionPro/HxMap



# Unified HxMap Processing Workflow for Higher Efficiency



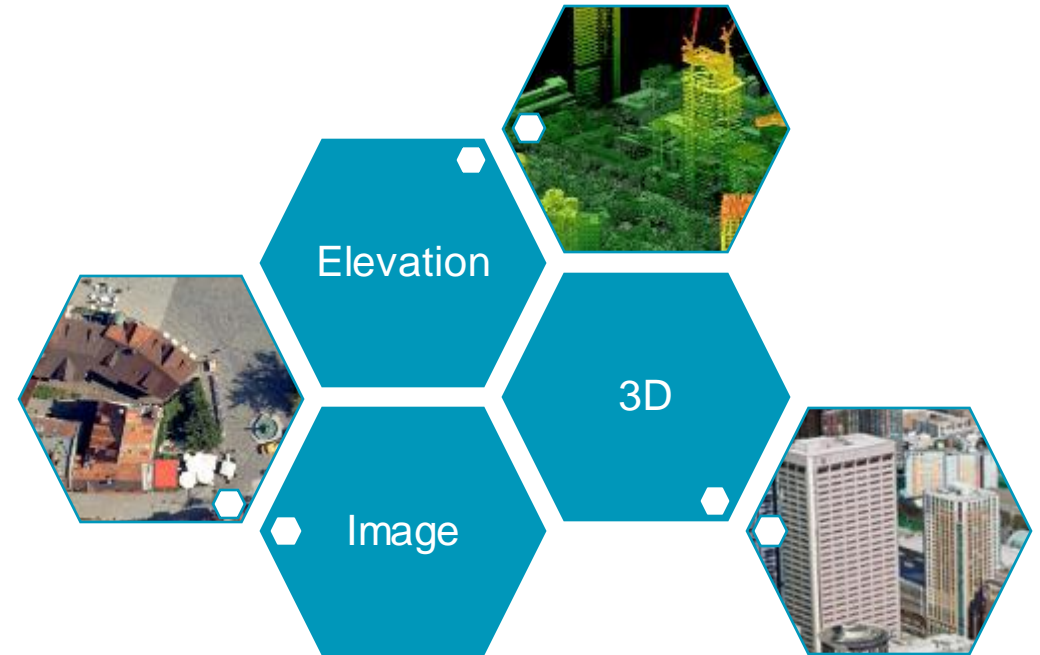


# Leica Geosystems Workflow Advantage

High performance, integrated workflow solution supporting multiple inputs and multiple products



Leica HxMap



**One Sensor**



**One Workflow**



**Unlimited** number of Data Products



# Derived analytics



An aerial photograph of a dense urban area, likely in Europe, featuring a central green space with a fountain and a construction crane. The image is overlaid with a blue gradient and a white diagonal line. The text "Managing urban areas" is written in white, sans-serif font.

# Managing urban areas



# Simulations

An aerial photograph of a city, likely Prague, showing a dense urban landscape with various buildings, a large park with a geometric garden layout, and a river. Overlaid on the image are several green arrows of varying thicknesses, indicating simulated movement paths or data flow. The arrows originate from the bottom left and fan out towards the center and right side of the image. A semi-transparent blue geometric shape is in the top left corner, and a white diagonal line runs across the middle left.





**Thank you!**

**Questions?**

[klaus.neumann@hexagon.com](mailto:klaus.neumann@hexagon.com)