Back to bare earth: LiDAR as a tool for archaeological investigation

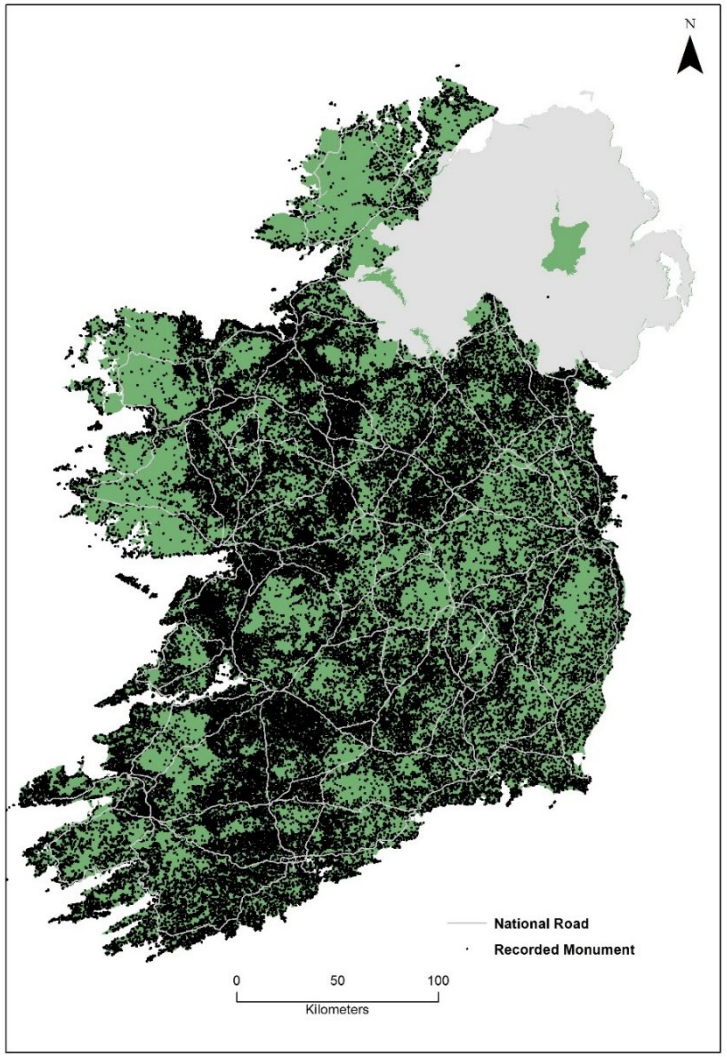
19/02/21

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Archaeology – Resource and Risk

Stone row, Ardamore, Co. Kerry

Rock art, Áth an Charbaill, Co. Kerry

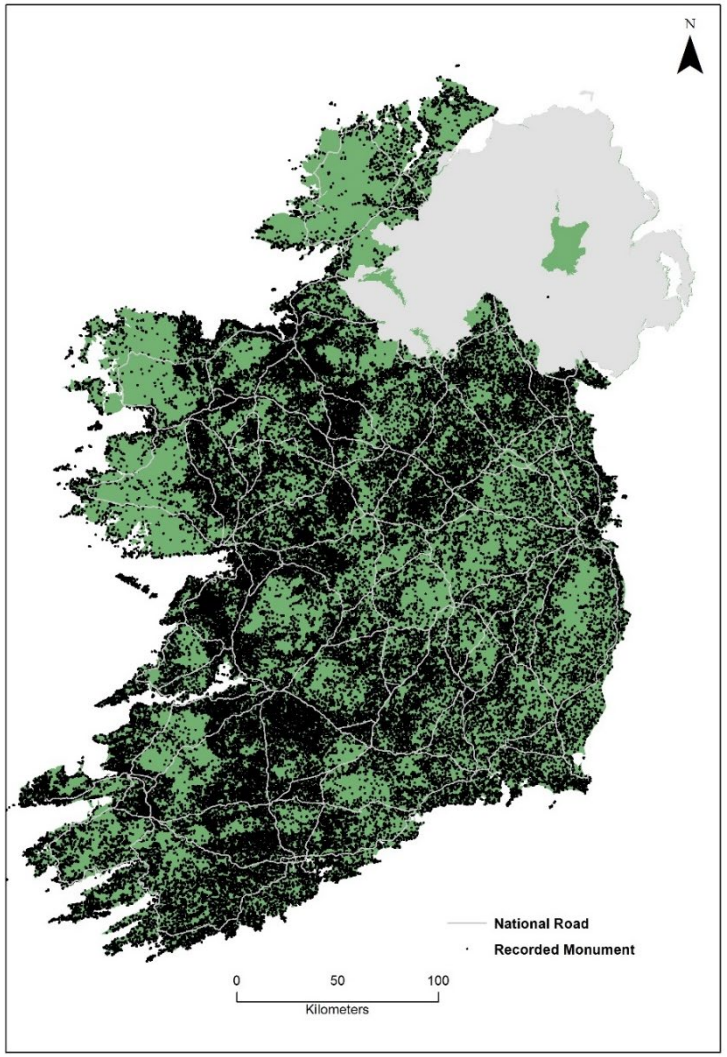


Distribution of recorded monuments in the Rep. of Ireland

Archaeology – Resource and Risk

Ringfort, Cappeen West, Co. Cork
(Photo: National Monuments Service)

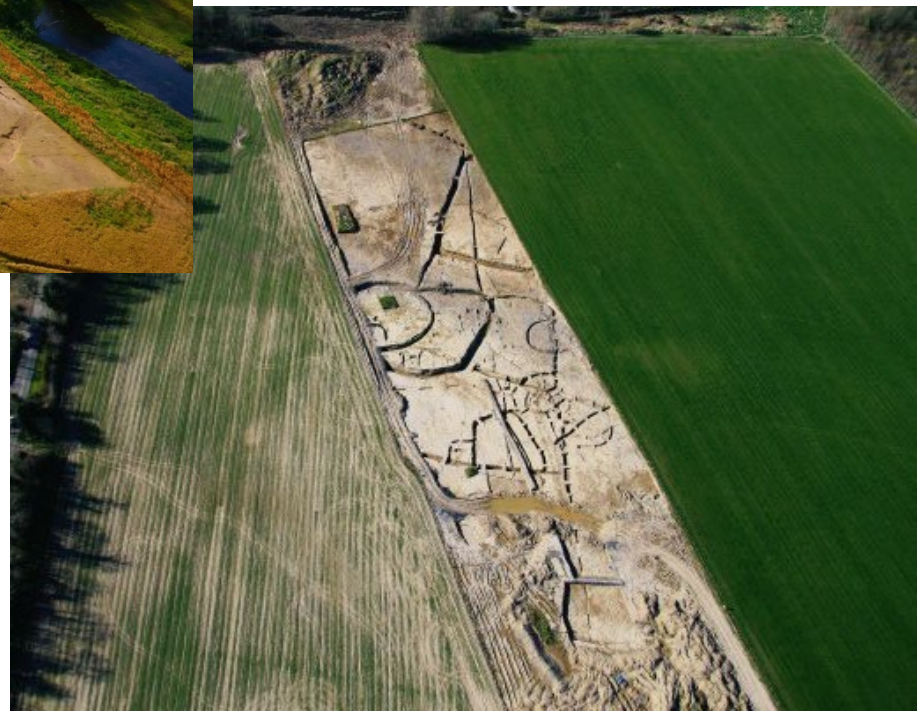
Ballybur Castle, Co. Kilkenny
(Photo: Patrick Comerford)



Distribution of recorded monuments in the Rep. of Ireland

Archaeology – Resource and Risk

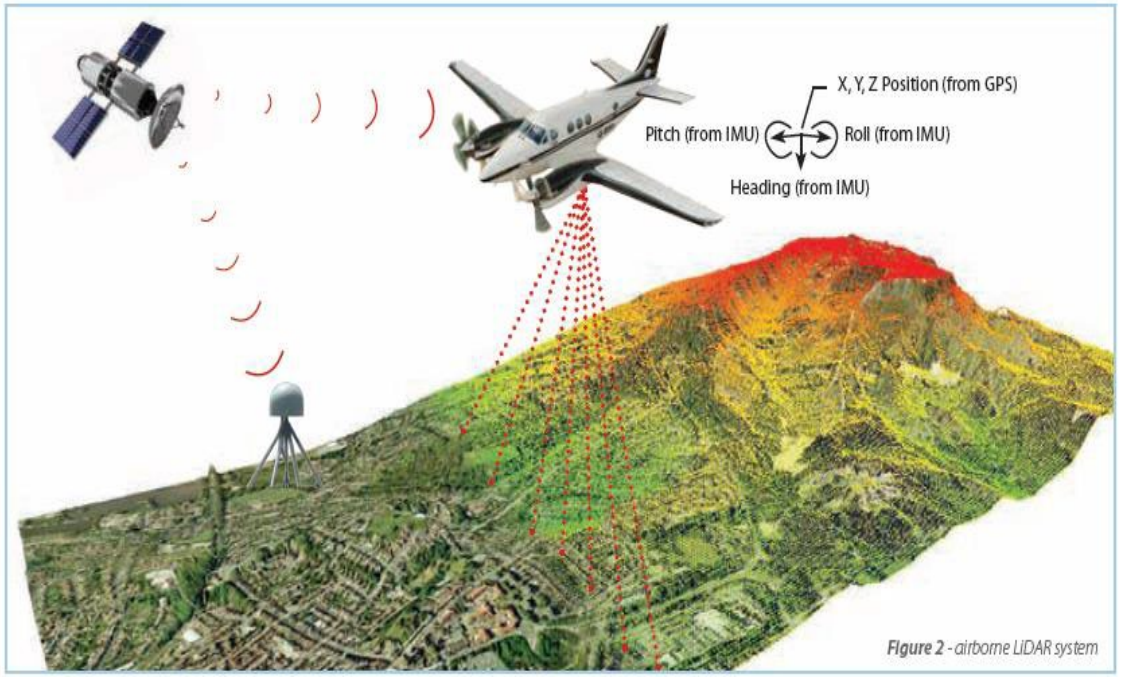
Castlesize early medieval enclosure, Co. Kildare (Sallins Bypass)
(Photo: KNRO & IAC Ltd)



Early medieval complex, Dowdstown, Co. Meath (M3 Clonee to North of Kells)
(Photo: StudioLab)

What is LiDAR?

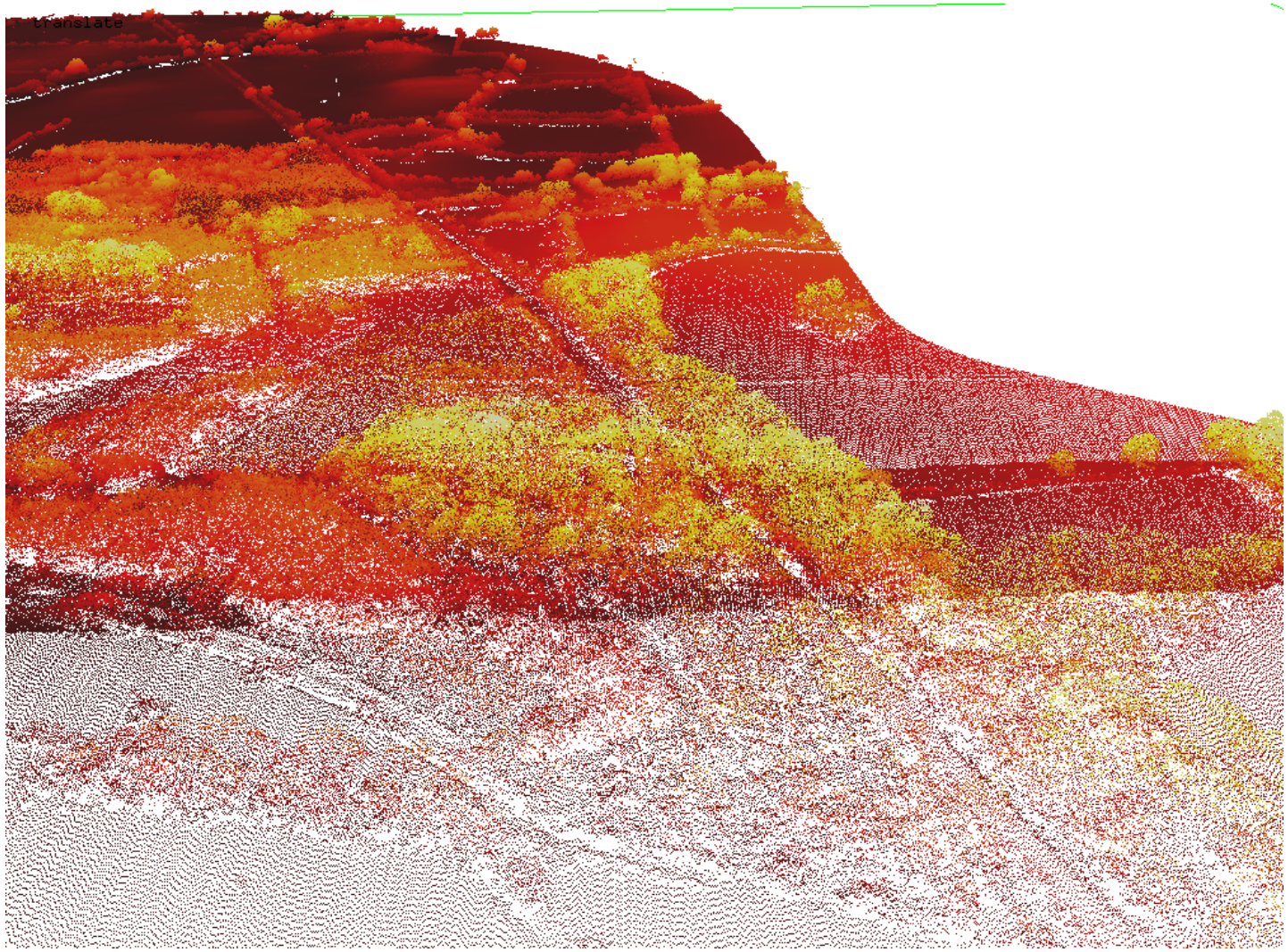
- Laser pulse is reflected off the ground or object it hits and returns to the receiver.
- Receiver measures the time of travel of the pulse from its start to its return.
- Travel time converted to distance measurement.



(Graphic: Bluesky Ireland)

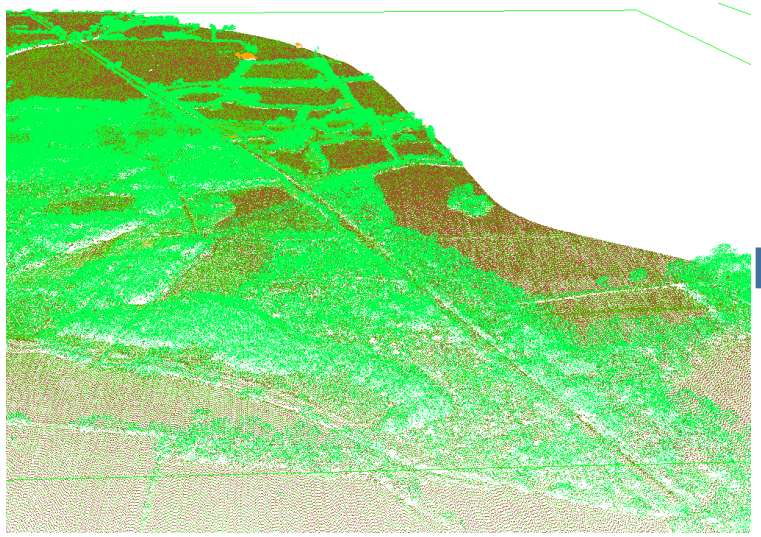
- Distance combined with laser position from GPS, and laser orientation from an inertial measurement unit (IMU) to calculate an accurate x,y,z coordinate for each pulse.
- Up to 150,000 pulses per second
- 500 sq km can be surveyed in a day

LiDAR Processing

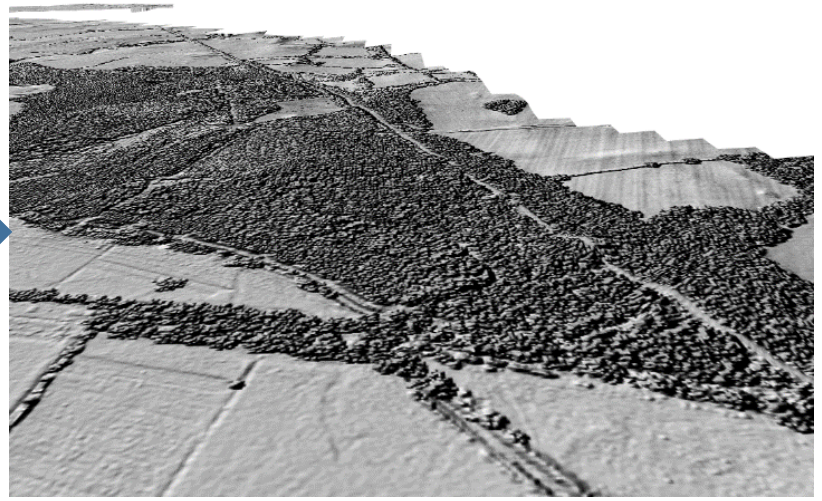


Raw point cloud - a virtual ‘cloud’ of points in 3D space

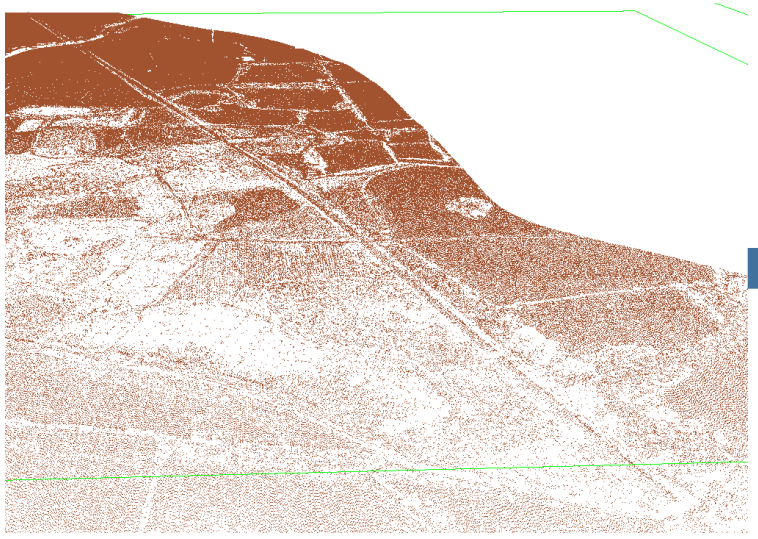
LiDAR Processing



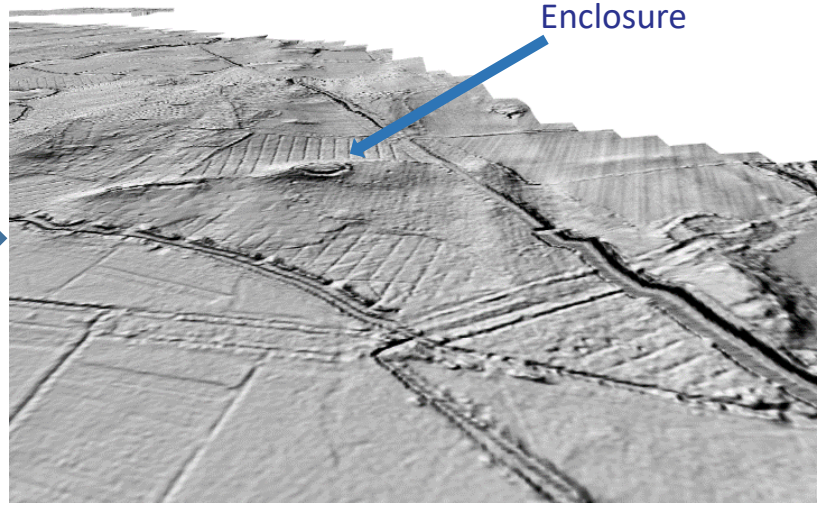
Classified point cloud



Digital Surface Model (DSM) - hillshade



Ground classification only



Digital Terrain Model (DTM) - hillshade

LiDAR Archaeological Assessment

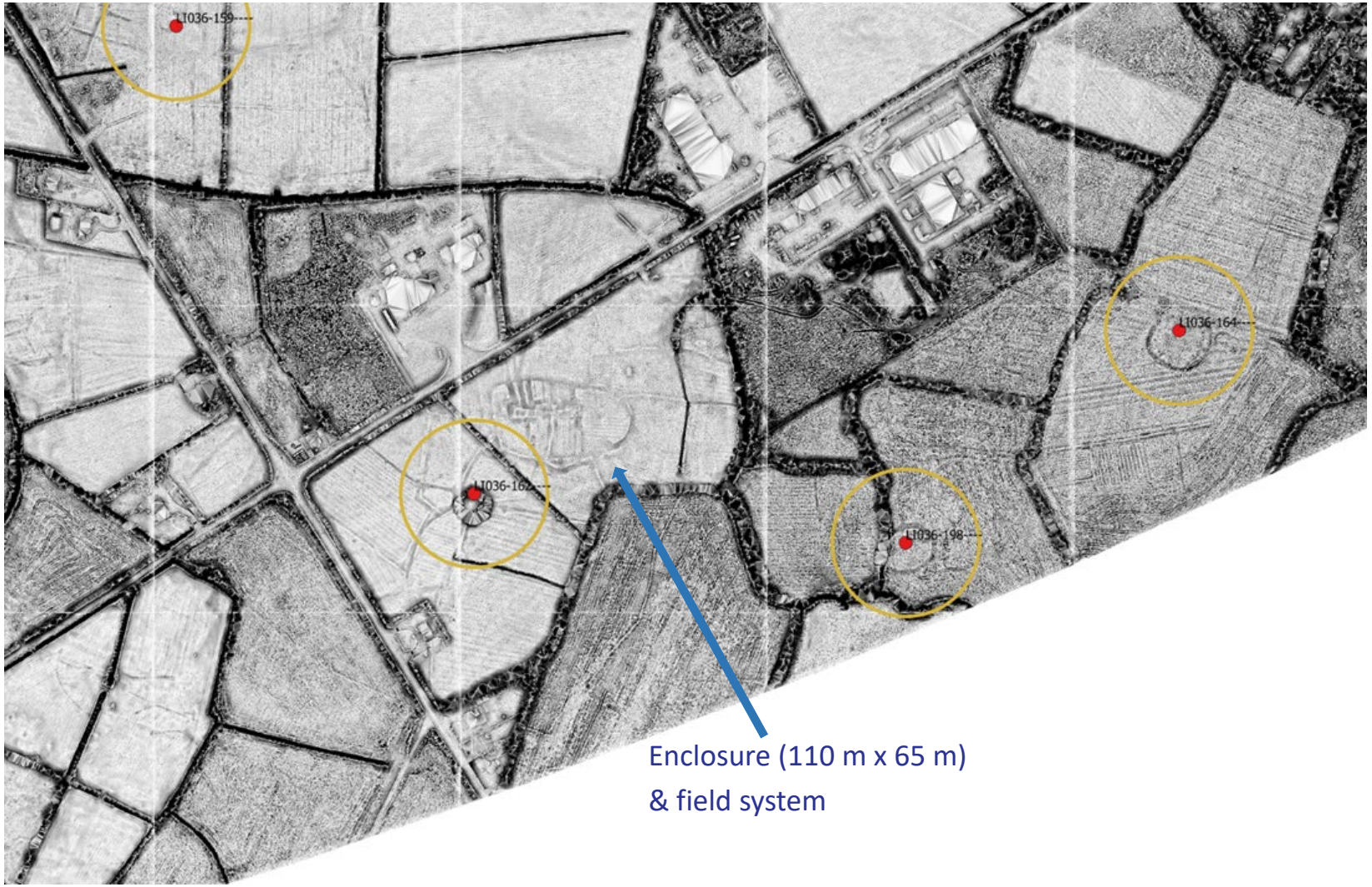
Scheme orthophoto

Hillshade from DTM

LiDAR Archaeological Assessment

Ballinvullin, Newcastle West, Co. Limerick; scheme orthophoto.

LiDAR Archaeological Assessment



Sky-view Factor produced from DTM

Phase 2 LiDAR Archaeological Assessment

Key Benefits

- Maximises risk reduction
- Early identification of potential National Monuments
- Avoidance of potential National Monuments through route realignments/selection
- Provides further information on the extent and condition of recorded monuments
- More informed assessment of route options
- Accelerates procurement and delivery of Phase 3 geophysical survey
- Informs the cost estimate and programme for the Phase 5 archaeology contracts

Key Challenges

- Scale of study area
- Limited private sector capacity to provide LiDAR Archaeological Assessment services

TII Open Research Call 2021

Automatic Feature Detection

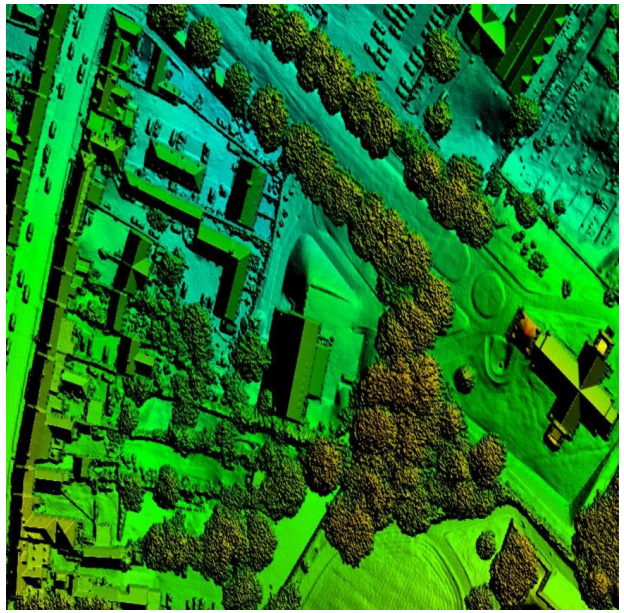
- Development of software tool/plugin for the automatic detection of archaeological features from LiDAR data using machine learning techniques
- Focus on potentially significant monuments
- Software tool and training to be provided to relevant TII staff and archaeological consultants

Key Benefits

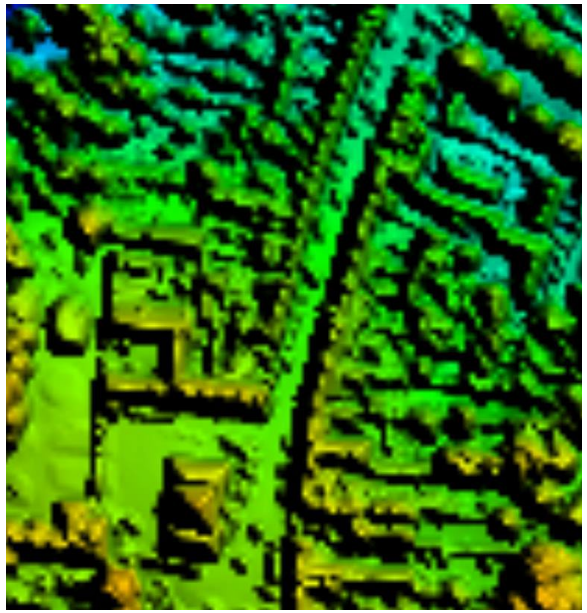
- Facilitate faster, more cost-effective archaeological assessment of large LiDAR datasets
- Increase capacity of the private sector to provide LiDAR Archaeological Assessment services

Quality of Outputs

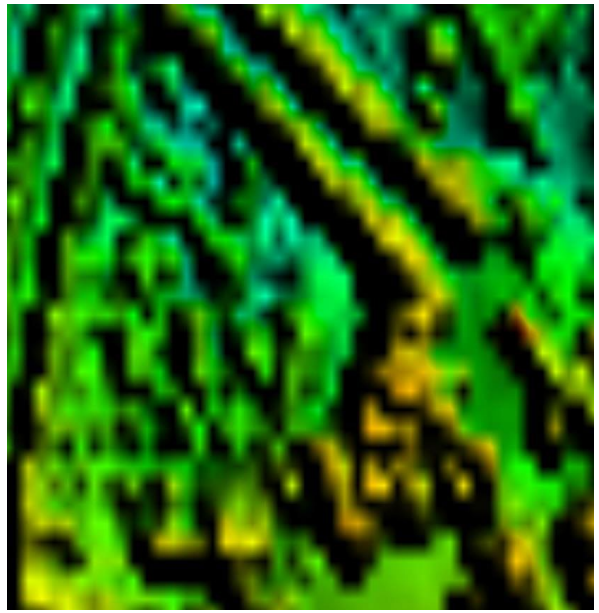
Quality of DTM/DSM depends on pulse density i.e. pulses per square metre (ppm)



0.25m DSM



2m DSM



5m DSM

- Pulse density ranges from 0.5–30ppm
- Optimum density in terms of quality, file size and cost is c. 8–10ppm
- High quality 0.5m DTM/DSM can be produced from a survey of 8–10ppm
- Pulse density of ‘off-the-shelf’ LiDAR data is typically 4ppm

Survey Window

LiDAR

- Surveys undertaken from mid February to end October
- Optimum is mid February to end of April (weather, vegetation die-back)

Aerial imagery

- Surveys undertaken from April to mid October
- March to June very good sun angle for imagery

Combined LiDAR and aerial imagery

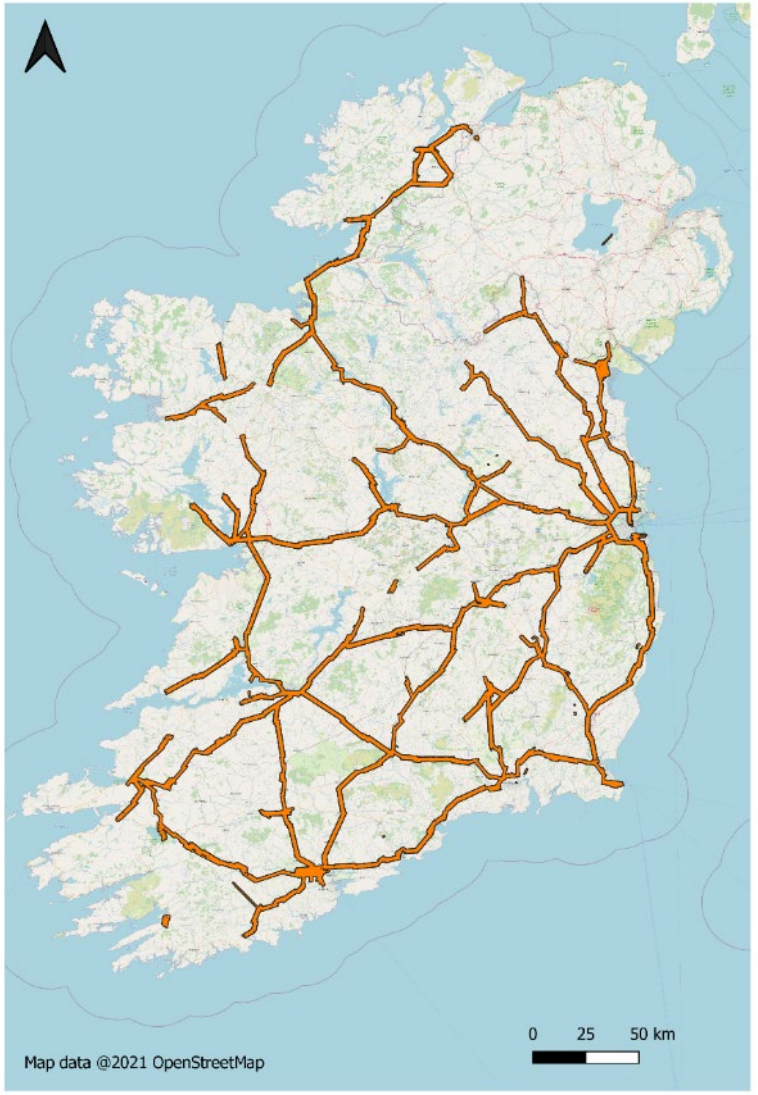
- Optimum for Lidar doesn't necessary coincide with optimum for aerial imagery, depending on purpose of aerial imagery e.g. vegetation health best captured in leaf-on window. Also sun angle and length of daily flight time best in leaf-on window
- Combined LiDAR and aerial image capture has narrower flying window of March/April as very good weather conditions are needed

Cost Factors

- Size of survey area
- Location of survey area – distance from base/refuelling airports
- Resolution – lower resolution data collected at higher altitude = greater swathe width = less flying time = lower cost e.g. 20-25ppm collected at 1800ft whereas 4-6ppm collected at 5500ft
- Deliverables required – processing costs
- Flight time is greatest cost – less value for money in commissioning small surveys
- If survey area is <300 ha consider using a drone/UAV
- Considerable cost saving if LiDAR is combined with image capture

TII LiDAR

- Surveyed 2010-11
- Processed 2 m DTM of 1 km-wide swathe available
- Raw data can be processed to higher resolution for 1.5-2 km wide swathe



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