Geometric Calibration of the Buckeye System

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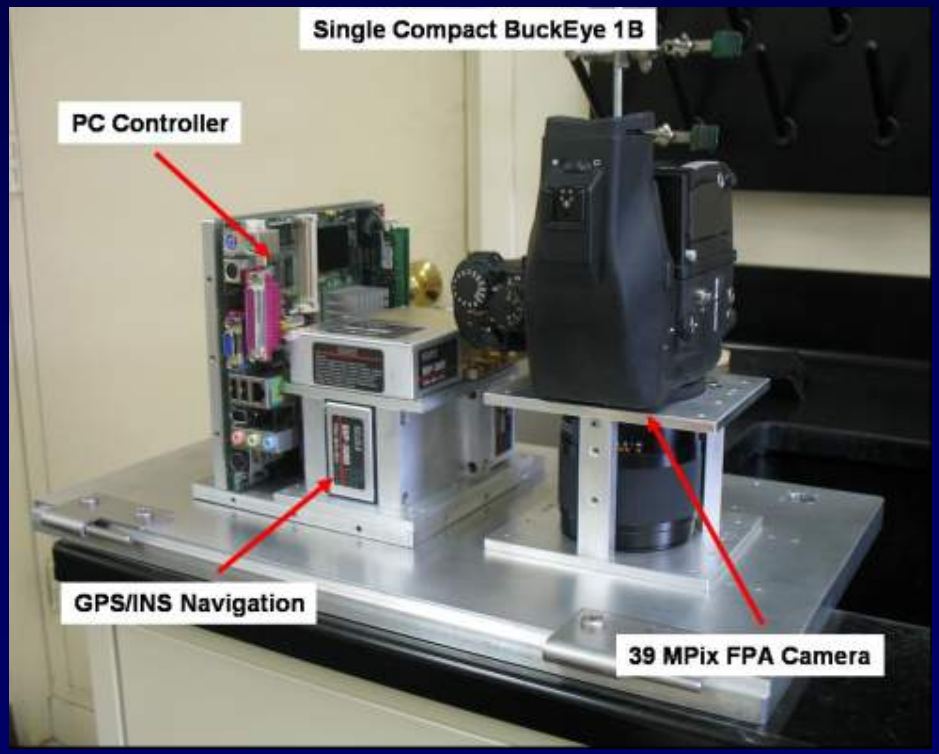
BUCKEYE

A field expedient detection system, which rapidly produces high spatial resolution imagery and elevation data to support military operations.

Collection System consist of:

Medium Format EO Camera



Optech ALTM 3100 LIDAR

Current EO Camera Buckeye 1B

Integration of following components performed by FightLand Data, Inc:

- Contax 645 Camera Body
- Phase One P25 Digital Back
  22 Megapixels- 5440x 4080 pixels
  9 Micron pixel size
- Suite of interchangeable Zeiss lenses with focal lengths of:
  35mm, 45mm, 80mm, 140mm, and 210mm
- Navtech GPS card inside computer controlling system
- Easily mounted in multiple platforms
- Lens suite allows missions to be flown at different altitudes to maintain desired resolution
- Relatively low cost

Next Generation Buckeye 1 B+

- New Phase One P45 Digital Back,
  39 MegaPixels – 7228 X 5428 pixels
  6.8 micron pixel size
- Tighter Integration to Optech LIDAR/ Applanix IMU-GPS to provide better direct Georeferencing
- UAV Implementation- Limited Real Time download
- Integration being performed by SAIC

Imagery Collection

Hardware/ Vendor Software

TEC Code

Positional Tagging

Radiometry

... Tie/GCP Point | Tie/GCP Point | Tie/GCP Point | Tie/GCP Point | Tie/GCP Point ...

Create Socet Support Files

Bundle Adjustment Mosaic/DEM

SOCET Set

In-House Processing Flow

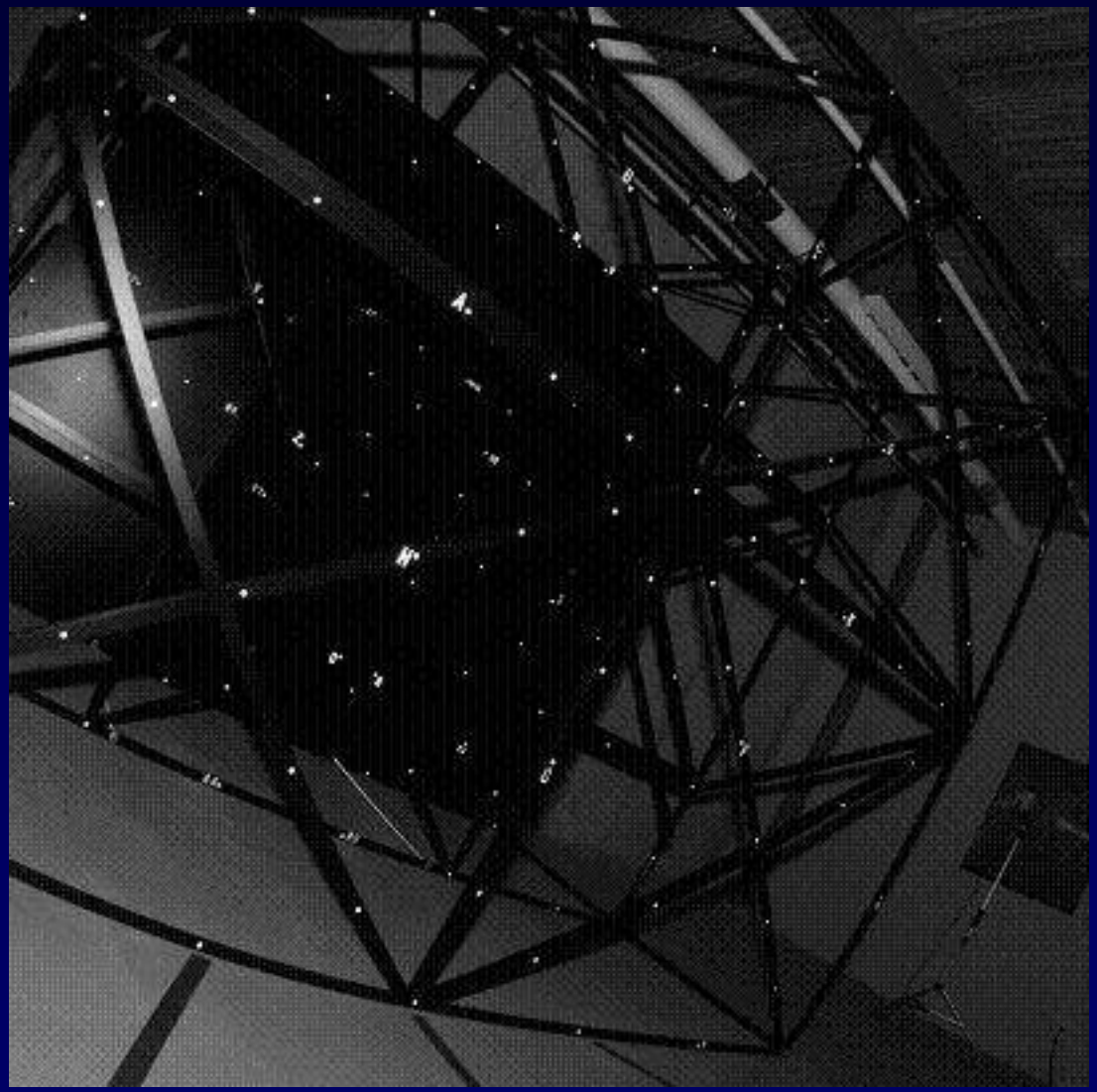
Geometric Calibration

- Calibration Cage
- Taut Line Method
- *InSitu* Calibration Range
- Camera Stability Analysis

Calibration Cage

- Installed by Pictometry in 2003
- Uses Australis Free Network Sol’n
- 12’W x 8’H x 8’D Dimensions
- 153 Signalized Points
- Nine Images from Nine Stations
- Originally Set Up for Medium Focal Length Lenses (35-80mm)

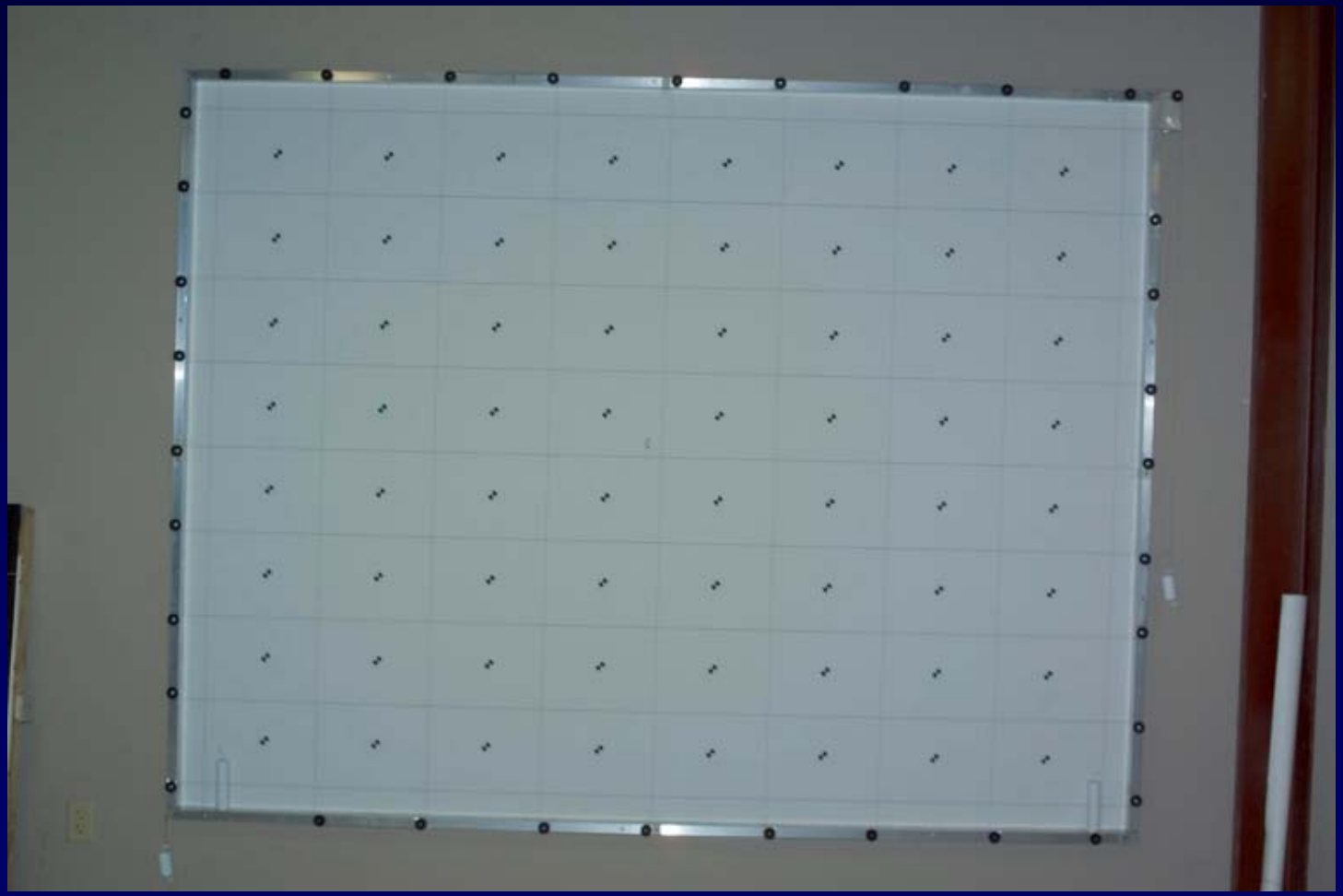
Wide angle image of Cage



Taut Line Method

- Developed by University of Calgary
- 8’W x 6’H Grid of horizontal and vertical lines with 64 points
- Four points are surveyed locations
- 12 Images from 6 stations (Landscape and Portrait)
- Can be used for wider range of focal lengths

Image of Taut Line



In Situ Range

- One mile (E-W) by one half mile
- Nine flight lines
  - Four N-S at base flying height
  - Two E-W at base flying height
  - Three N-S at base plus 20%
- No *a priori* information needed

Camera Stability Analysis

- Another Univ of Calgary Tool
- Verifies Calibration Stability over Time
- Image space grid projected to ground using first calibration and re-projected to image using second
- Produces image space statistics

Calibration Methods used on Buckeye

- Cage Method:

  Standard procedure for all lenses 22 MP and 39 MP cameras

  Radial lens distortion, lens decentering and calibrated focal L.

  Experiments performed to simulate fielded conditions-

  Removal and re-install of lenses

  Removal of digital back

  Variable focus settings

  Emphasize that radial lens distortion and lens decentering coefficients are reported as corrections (sign change may be needed for some SW)

  RMS improvement of up to 6 times (X,Y, Z)
- Taut Line Method- Images taken, work in progress

- Research In-Situ Method

  EROS Range flown, all points measured, initial triangulation done, work in progress for calc. focal, radial and decentering

Long Focal Length Problems

- Weak Geometry
  - Narrow field of view
  - Convergence angle in laboratory
  - Principal point recovery
- Out of focus images in laboratory

In-Situ Flight-line layout for 210mm

Flights flown w/ Buckeye 1B+
Dec 15 2006

4 North-South lines @10,000 ft
Alternating direction

2 East-West lines @ 10,000 ft
Alternating directions

3 North-South lines@ 11,750 ft
Alternating directions

Total of 84 Images used

Buckeye Ortho-mosaic showing control point layout

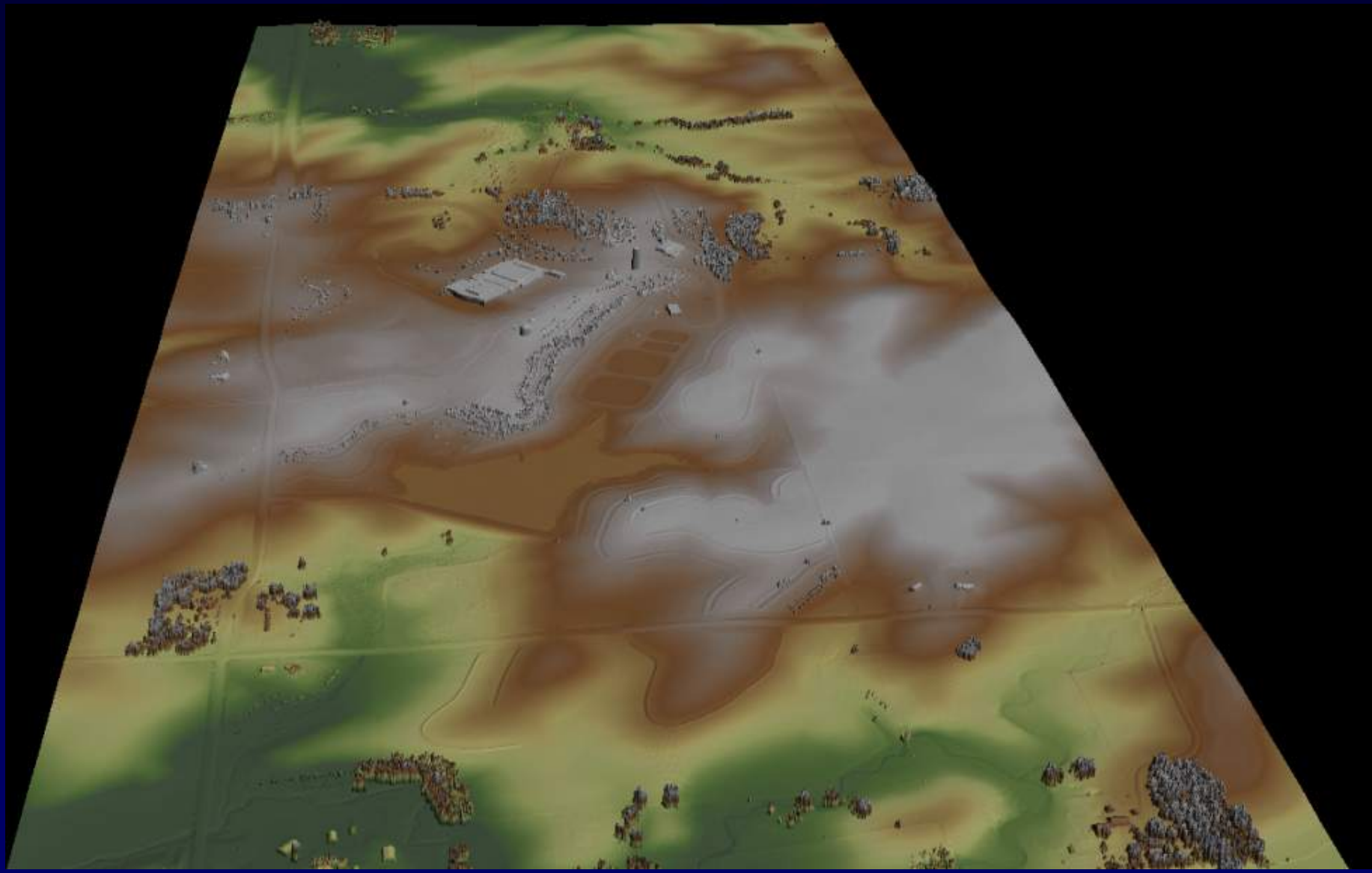
Supplemental Control Points added for LIDAR Evaluation RTK GPS accurate to 2 cm

EROS Data Center- portion of Buckeye image flown from 11,750 feet

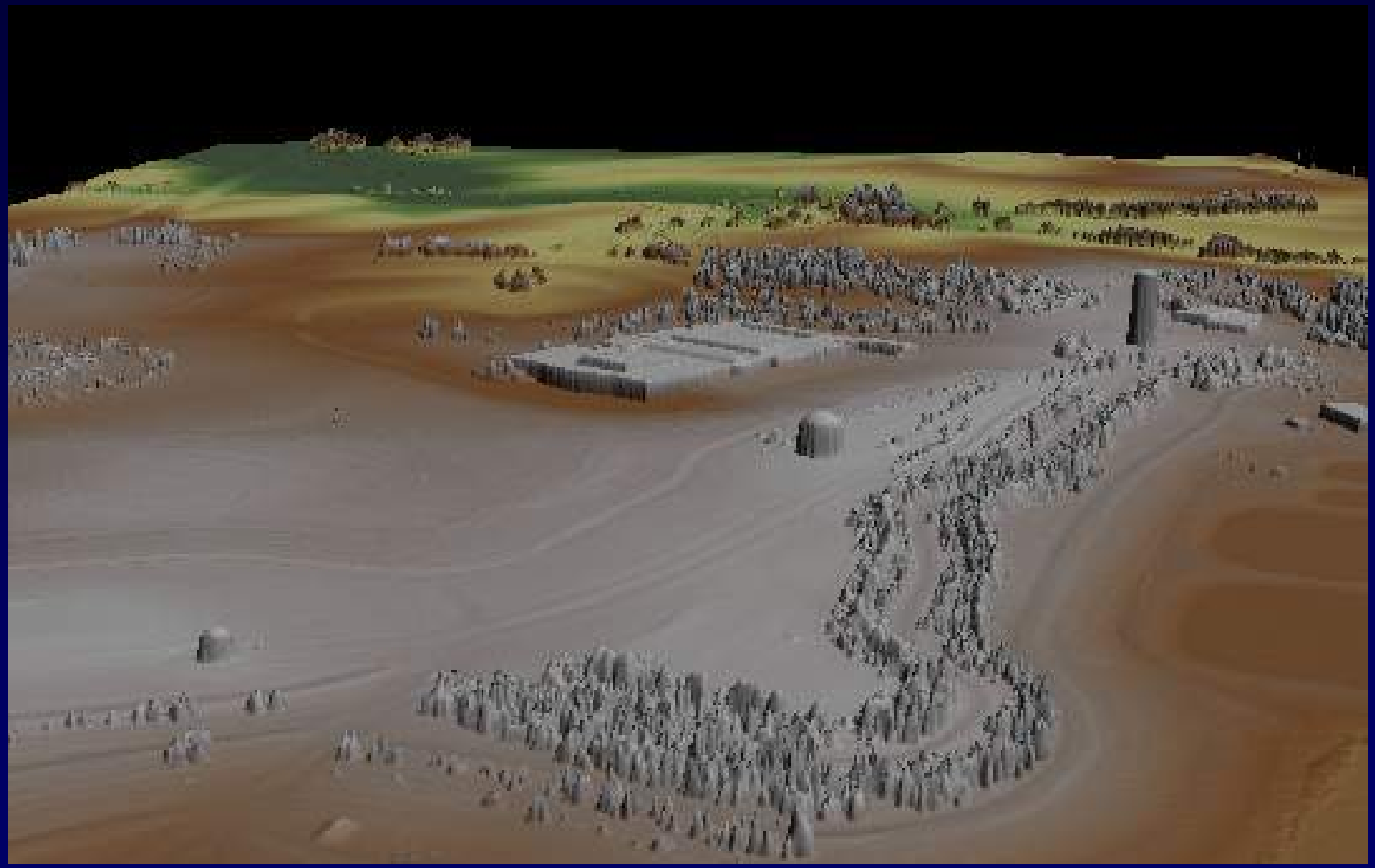
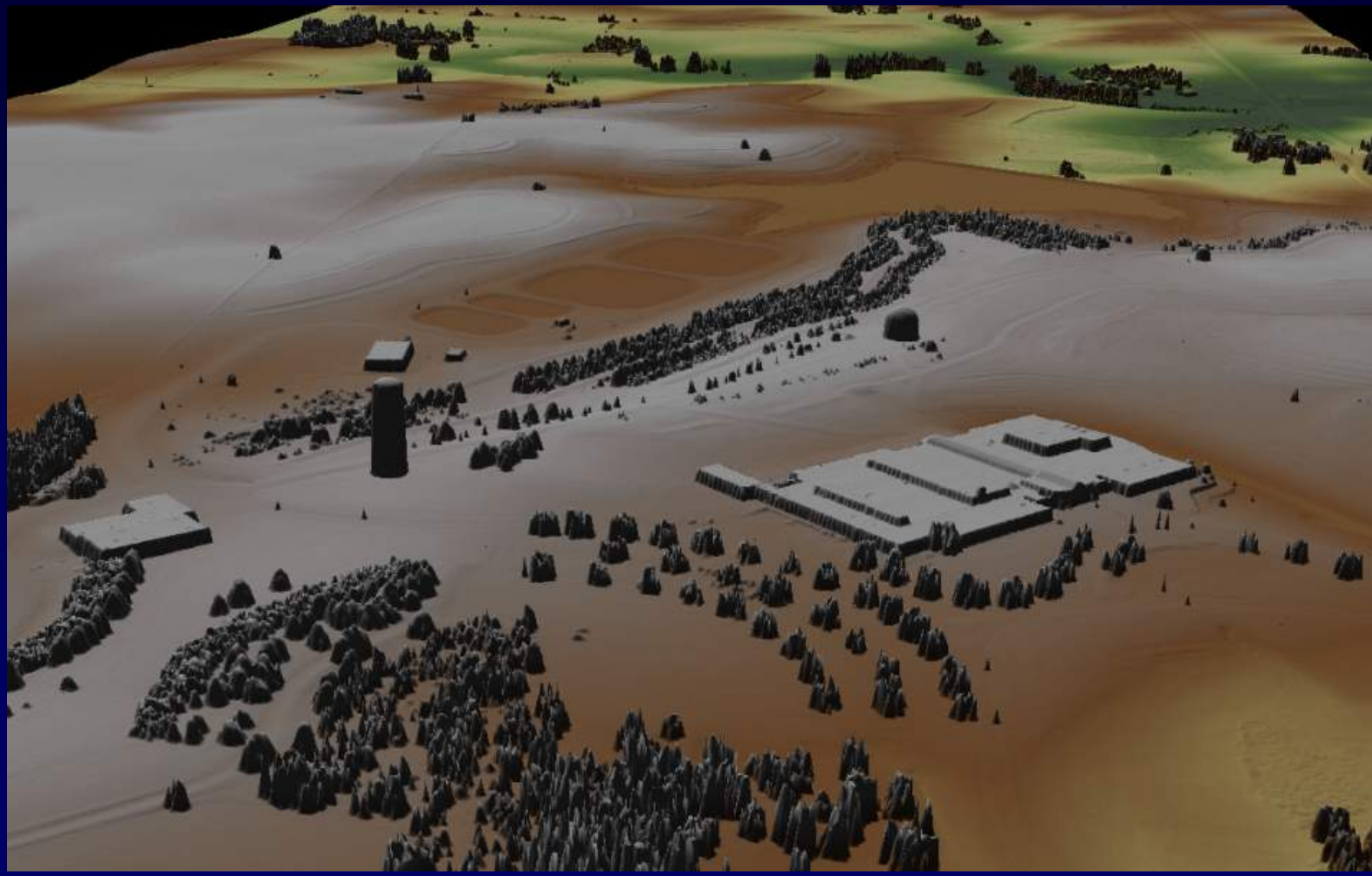
EDC Shop and two types of control points

Lake EROS and two types of control points

Overview Perspective LIDAR, EROS 60cm



Perspective LIDAR, EROS West



Perspective of LIDAR EROS