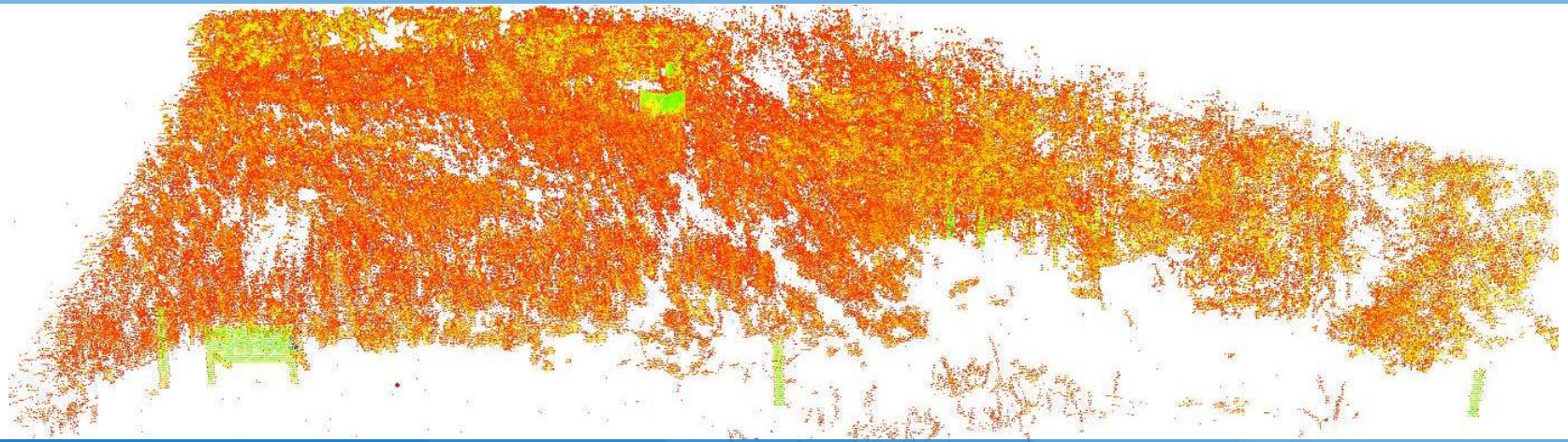

Panoramic 3D-Imaging Using Single-Photon Counting Laser Radar

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Agenda

- Why panoramic 3D laser radar?
- Experimental examples
  - Single pixel lab system
  - Array detector system
    - First results of system under development
- Performance outlook

Why panoramic 3D laser radar?

- 3D signature difficult to hide
- Ladar gives foliage penetration
  - Photon counting maximizes range resolution
- Ladar gives day and night capability

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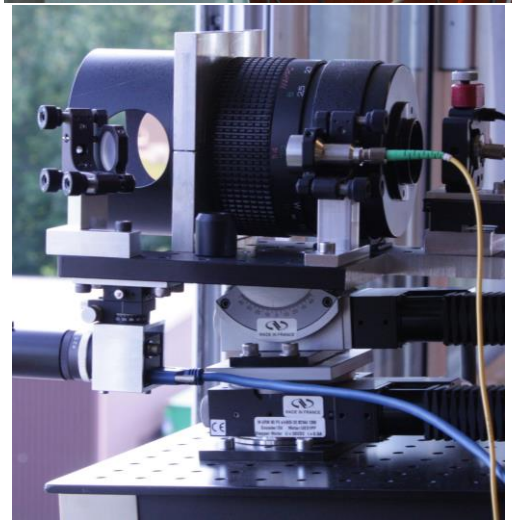
Scenario

- (Temporarily) fixed installation
  - E.g. camp, command post, etc.
- Locally open area, but forest (or smaller vegetation) in view
  - Concern for
    - Observers
    - Assault preparation
- Continuous surveillance necessary

Photo Mats Carlsson/Försvarsmakten

Single pixel experimental system

- Time correlated single-photon counting lidar
  - 1550 nm
- Single pixel
  - Sweeping row by row

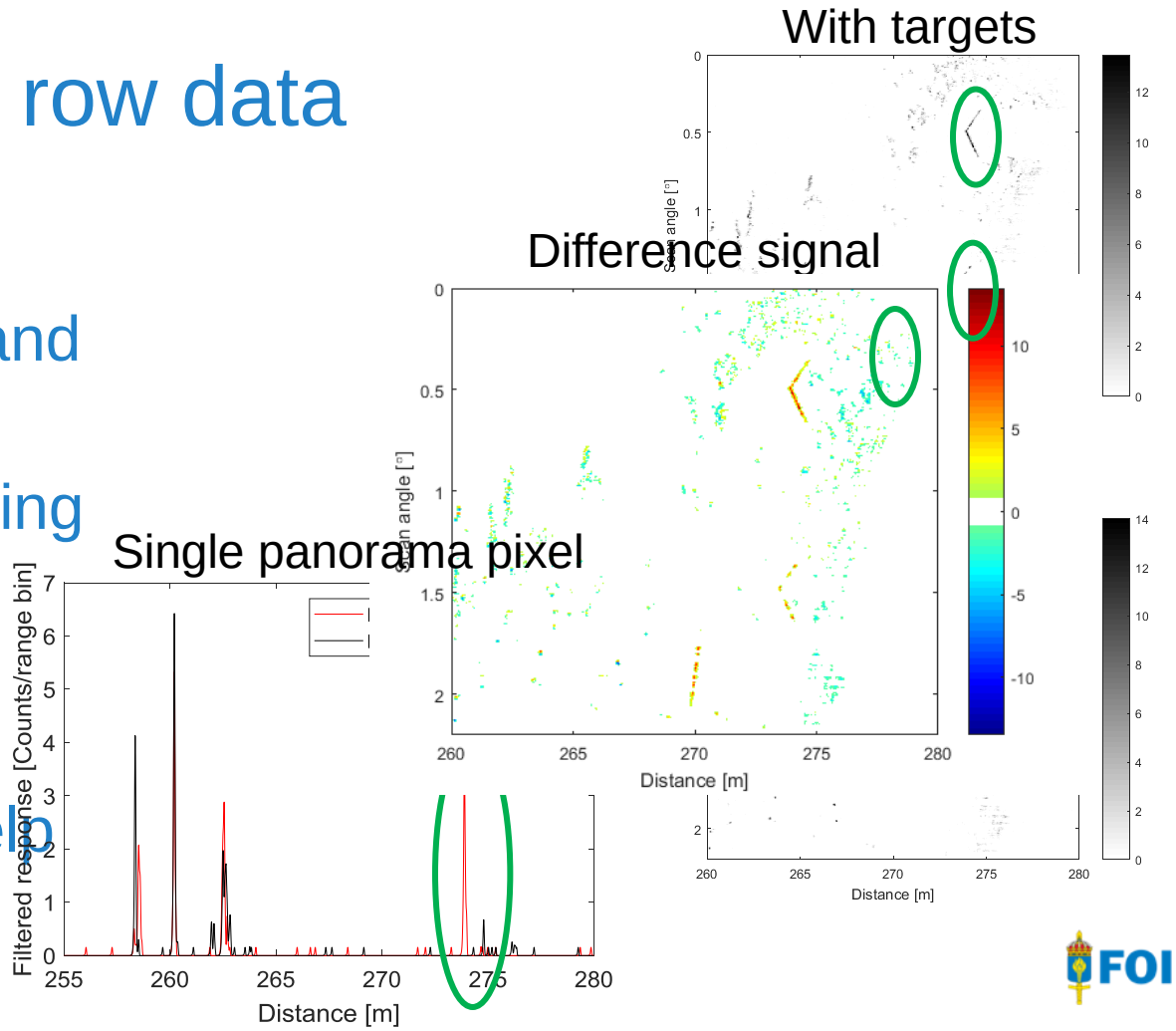


Experimental scenario and scene

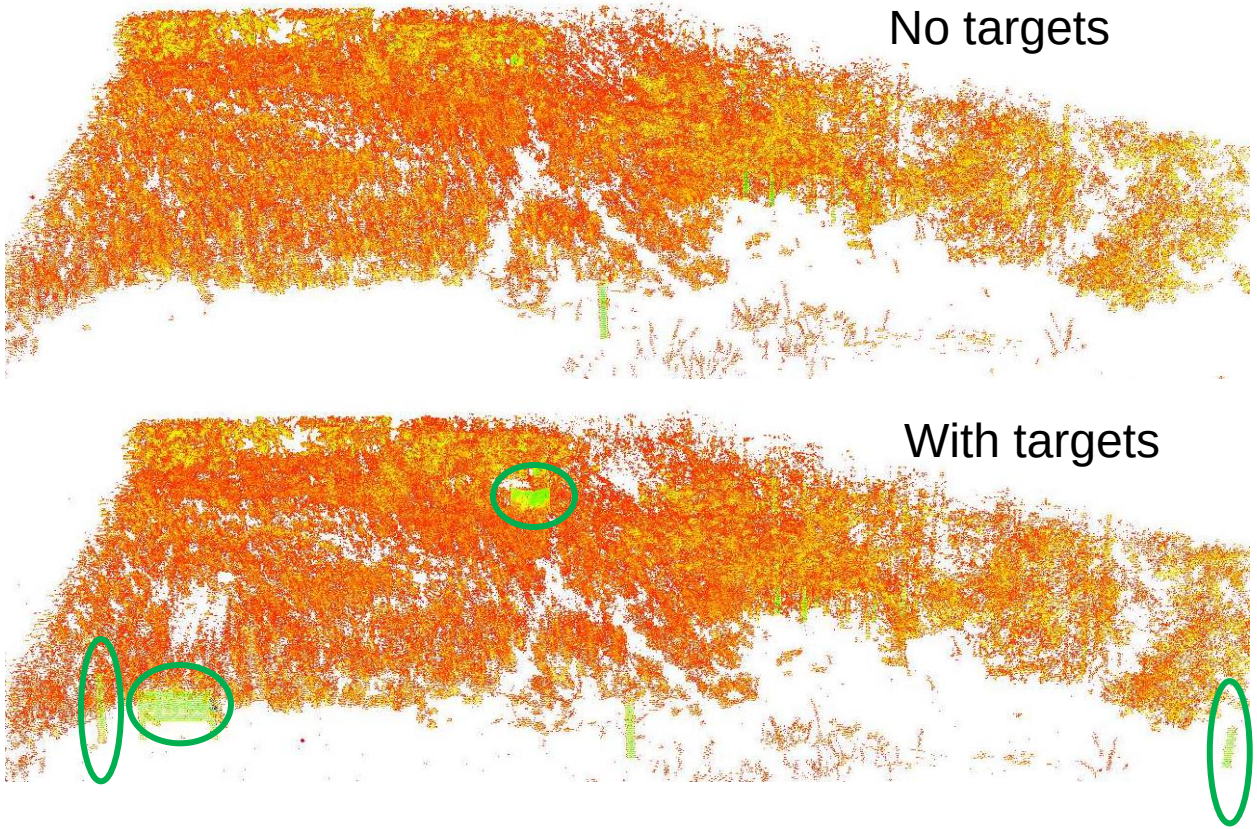
- Forest edge at ca 260 m
- Targets open and hidden
- Measured with and without targets
  - ~10 minutes per scan

Example single row data

- Signal strength as function of angle and range
- Manual target finding possible
  - But this is one of many rows
- Difference may help



Example 3D panorama point cloud



- Full 3D point cloud
- Targets are difficult to find

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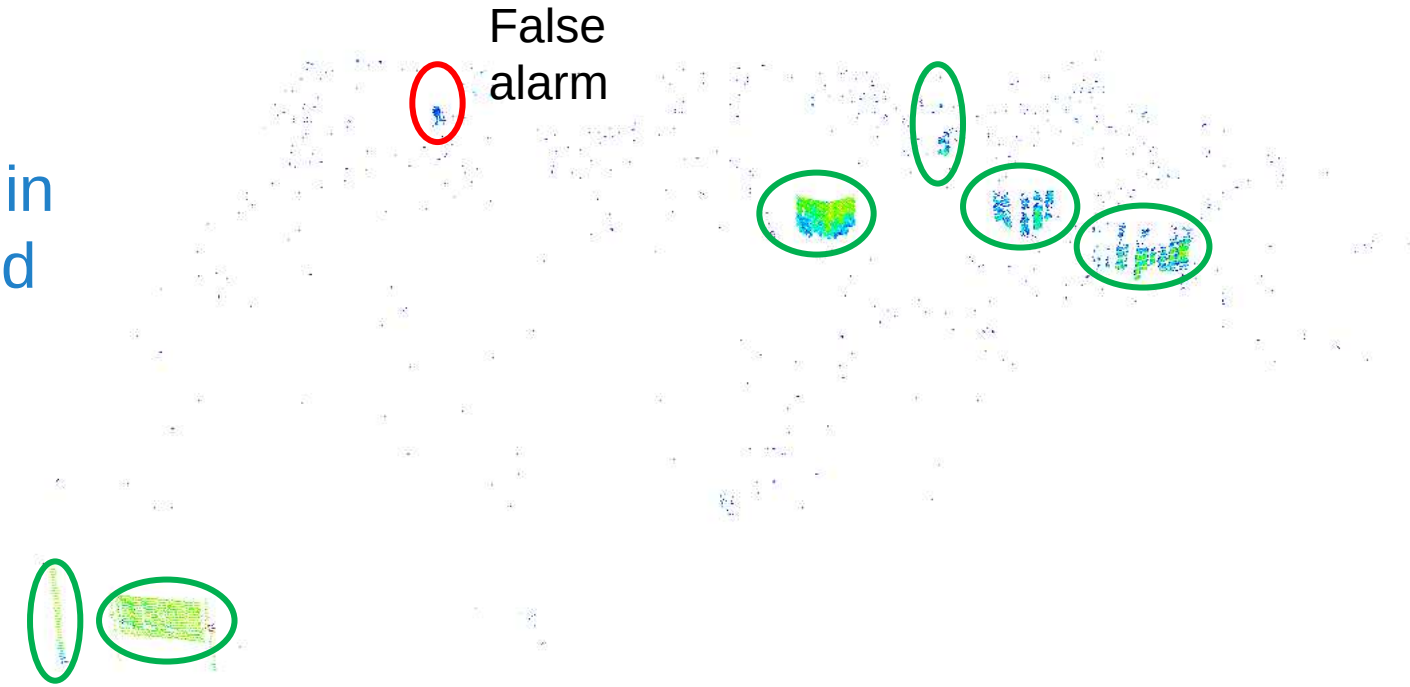
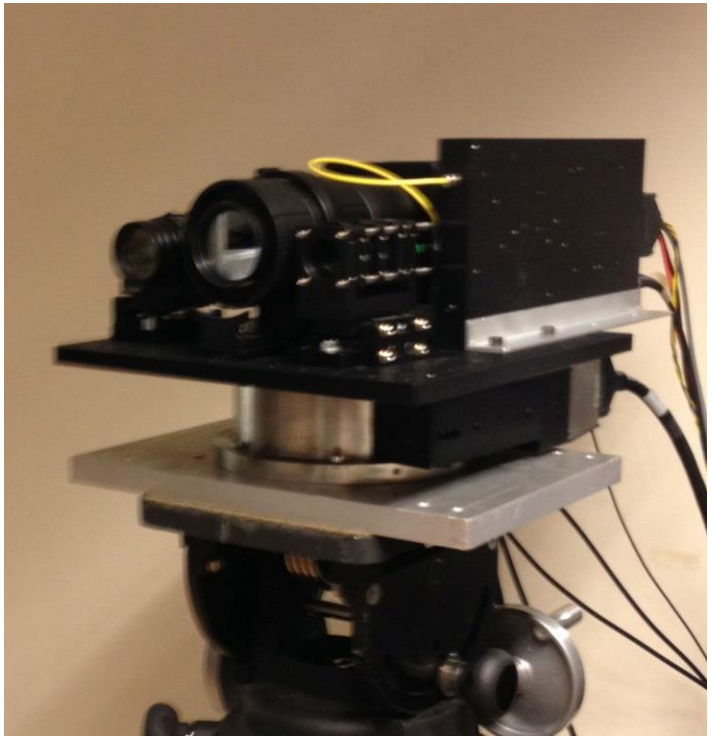
Example 3D change detection

- Change detection in point cloud



Array detector system

- System under development
  - Princeton Lightwave Inc Falcon 3D LIDAR camera
    - 128×32 array of Gm-APD detectors
    - 90 kHz frame rate
  - Short pulse laser (0.57 ns)
  - Rotation stage for panorama imaging
- 0.5 mrad IFOV
  - 0.2 m at 400 m
- 20°/s rotation



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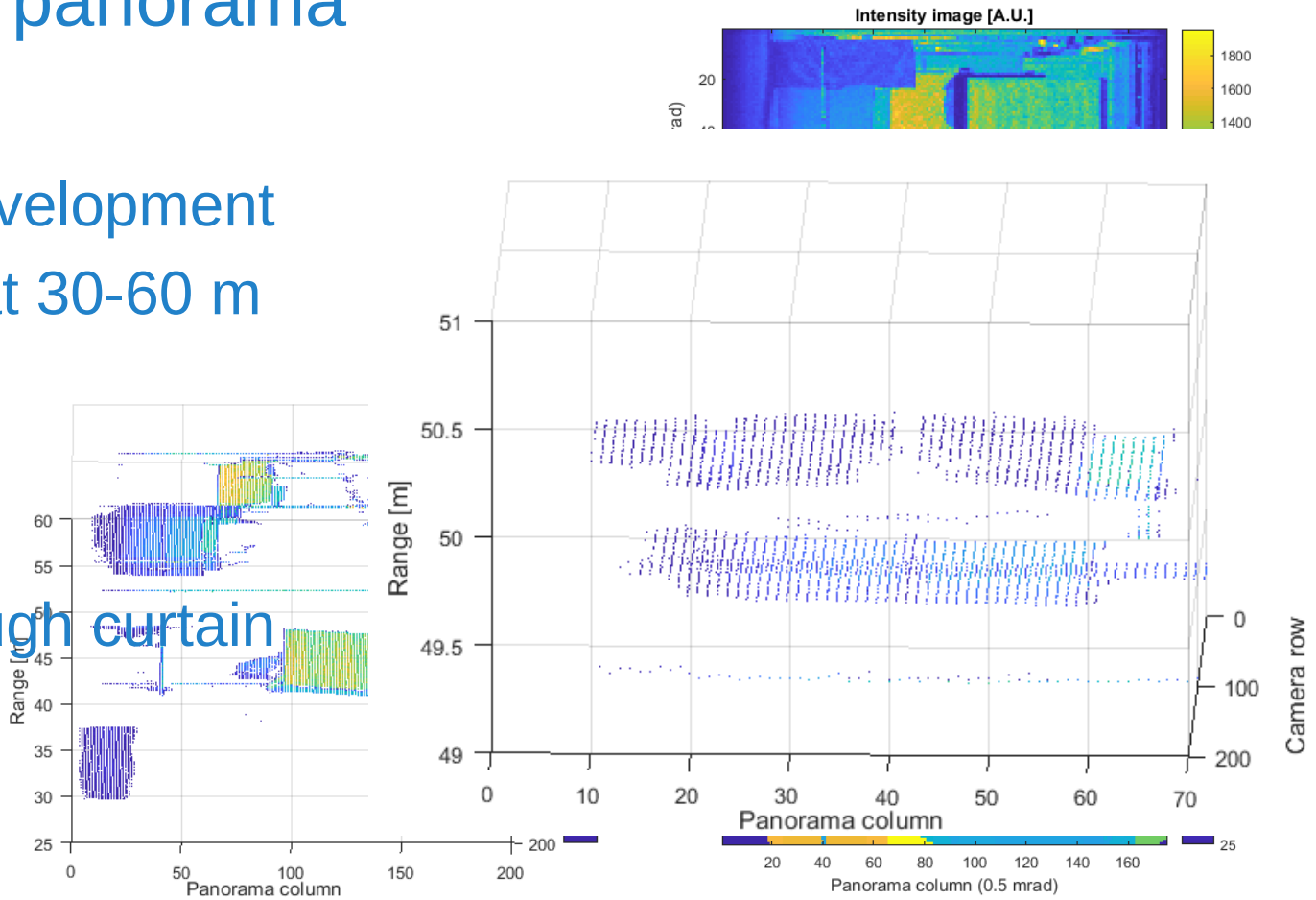
Example 3D panorama image

- Still early development
- Test scene at 30-60 m
  - Indoor
- 4° sweep in 205 ms
- Seeing through curtain



Performance outlook

- 360×3.7° with 0.5 mrad IFOV in 10 s
  - 2292 measurements/pixel
    - Should allow foliage penetration
  - Detector development will improve numbers
- Narrow dynamic range for Gm-APD
  - ~0.5 photons/pixel/pulse ideal
  - Laser power may need adaptive control
- Low time lag (seconds or below) processing expected
  - Static sensor
  - Change compared to previous rotation

Conclusions

- High data rate of photon counting arrays allows 3D surveillance
  - Foliage penetrating capability
- 3D change detection
  - Detection of activity
  - Flag for operator