Blackmore HRS-3D Introduction

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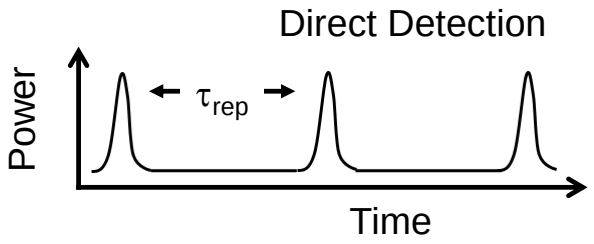
Overview

- Technology introduction
- Sensor details
- Data and results
- Key Questions

Technology Introduction

FMCW Technology

Most 3D lidar systems are pulsed, "direct detect" based. So what is the problem?



Pulse BW
Detector BW
Digitizer BW
Peak Power

Limiters to rep rate, resolution, and range

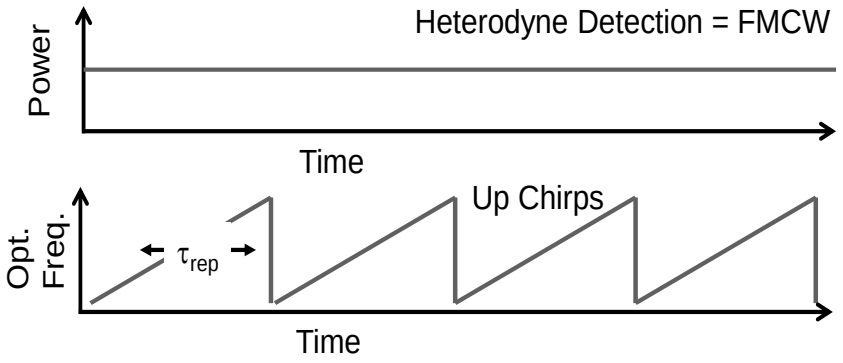
FMCW Uncouples Traditional System Limitations

Electronic Bandwidth

Optical Bandwidth

Peak Power

Constant Power / Frequency Modulated



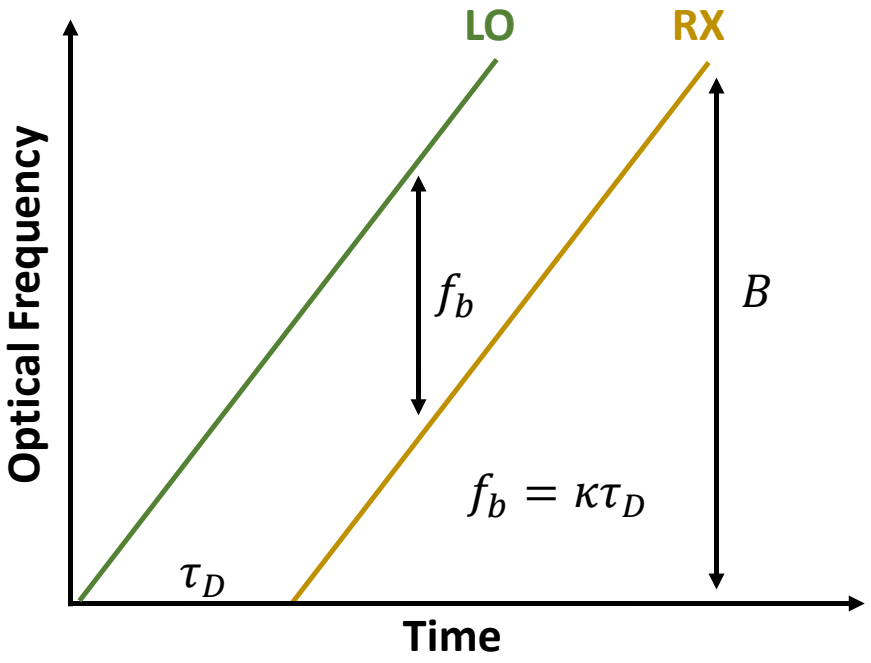
Flexible and adaptive technique which provides compelling advantages

Superior Resolution,
Dynamic Range,
Single Photon Sensitivity

Doppler Measurement
Multi-Return Resolution
Eye Safety
Low Cost

FMCW Technology

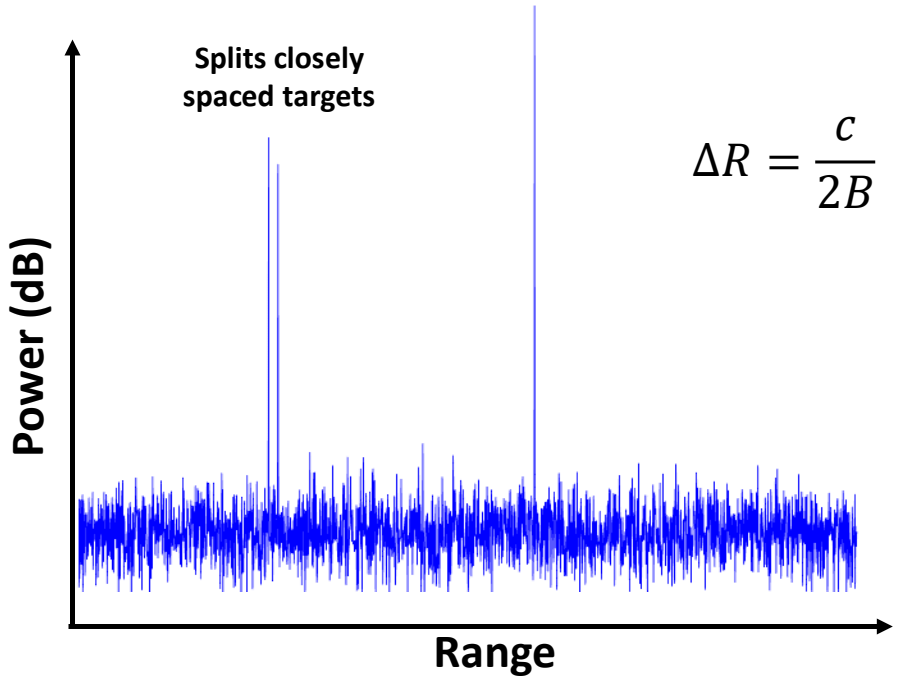
The properties of light are leveraged to make a physically superior measurement



Result is a beat note with frequency f_b that is digitized and processed.

FFT to get "range profile"

The optical bandwidth, *B*, can be increased to meet any resolution requirement



Result is extremely precise ranging results and crisp point clouds

Key Takeaway

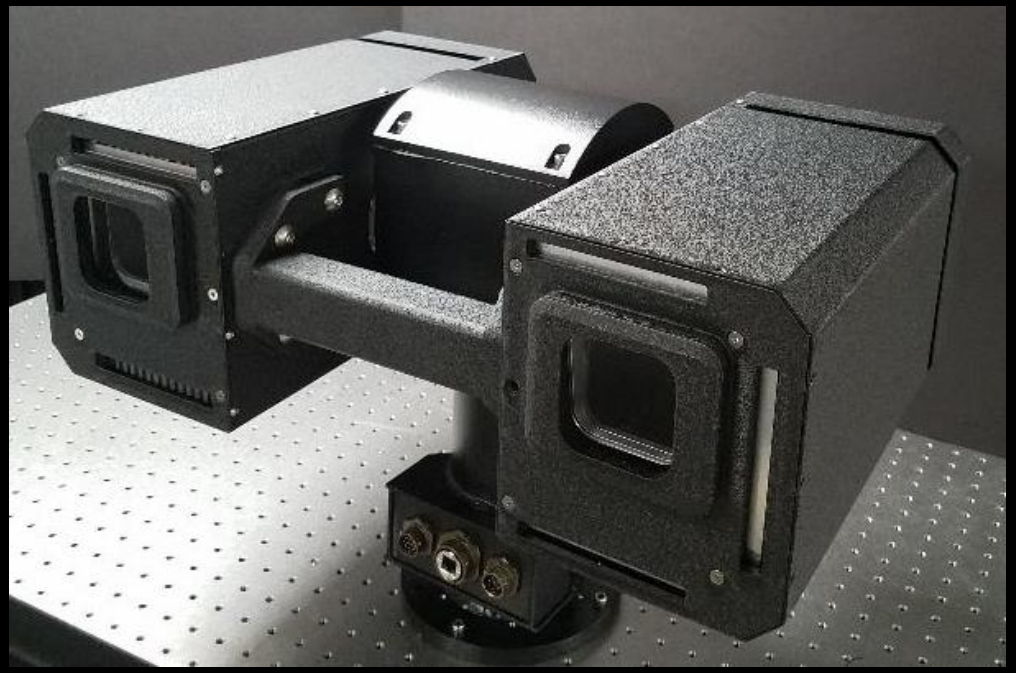
- Range resolution and range noise are both a function of chirp bandwidth
  - dR = c/2B
- Chirp bandwidth can be changed in software
  - Team has experimented with systems from 300MHz to 5THz chirp bandwidth
  - HRS upgrades can achieve >10GHz ranging bandwidth (extreme for long range lidar)
- Part of broader trade space including
  - Range window
  - Measurement rate
  - Range delay/gate
  - ADC rate

HRS-3D Details

HRS-3D

1. **Lidar Engine and Compute** support range-Doppler measurement
2. **High-Res Color Camera** provides video feed for user orientation and sensor fusion (RGB overlay)
3. **Pan-Tilt Unit** allows infinite azimuth and 300° elevation coverage
4. **Scanner** provides real-time 3D imaging in narrow FOV
5. **Base** connects to power and ethernet

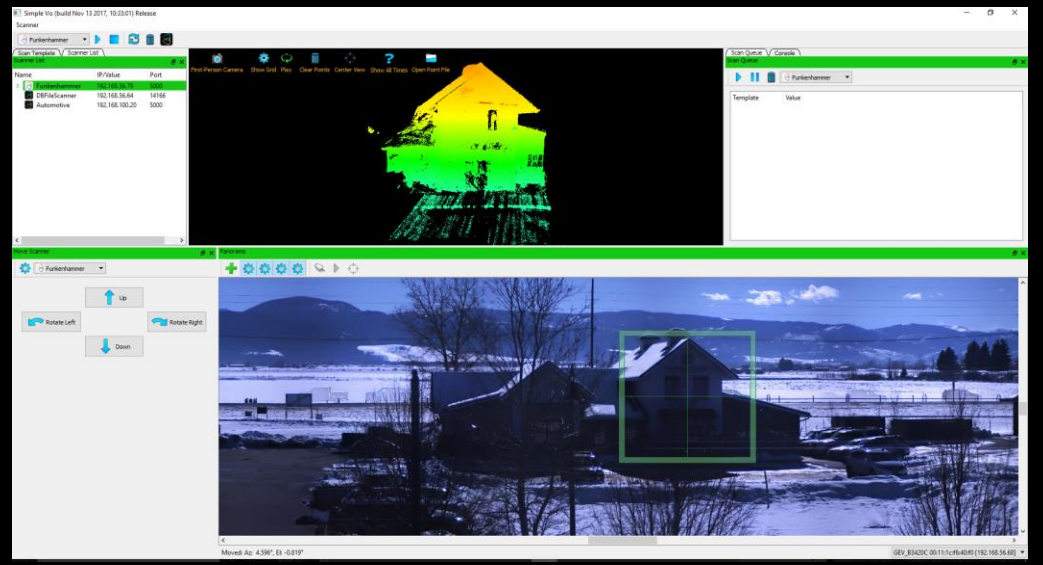
Finished Product

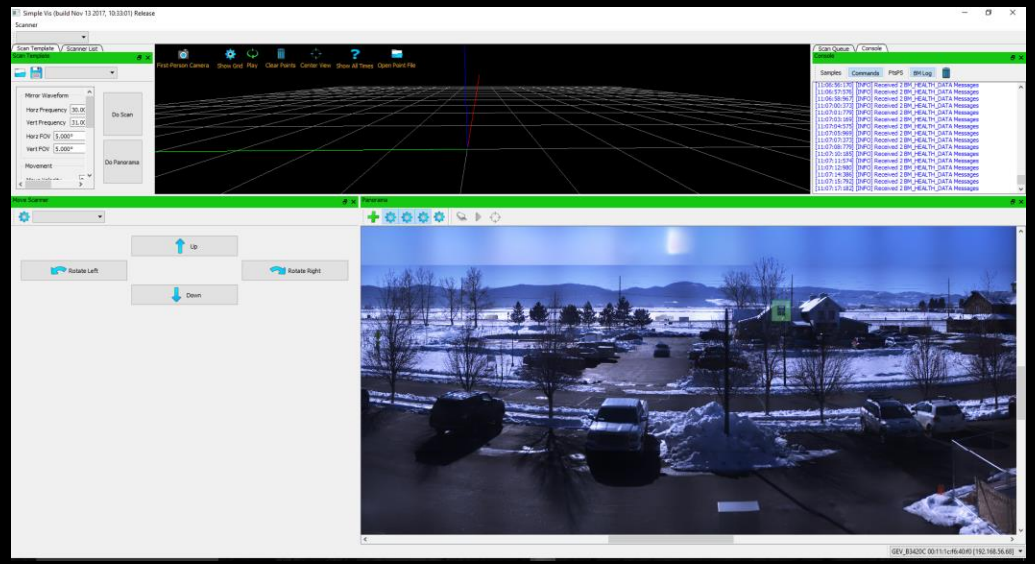


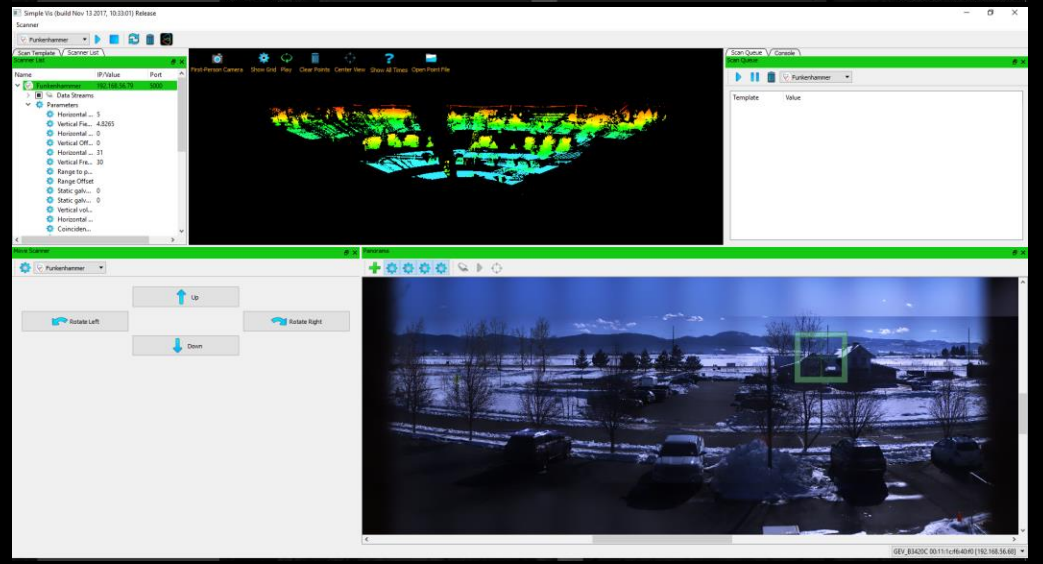
Max Range	2km
Range Resolution	<7.5cm
Range Noise	<1cm
Beam Divergence	<0.005^{o}
Laser Classification	Class 1
Interface	Ethernet / Blackmore API or GUI
Real time data products, Fully programmable operation	

GUI Software

- HRS-3D-specific GUI application
- Integrates RGB camera with 3D data
- Enables static mapping and dynamic control of HRS-3D
- Robust queuing features
- Static workflows designed to be familiar to existing customers
- Dynamic workflows take advantage of new functionality

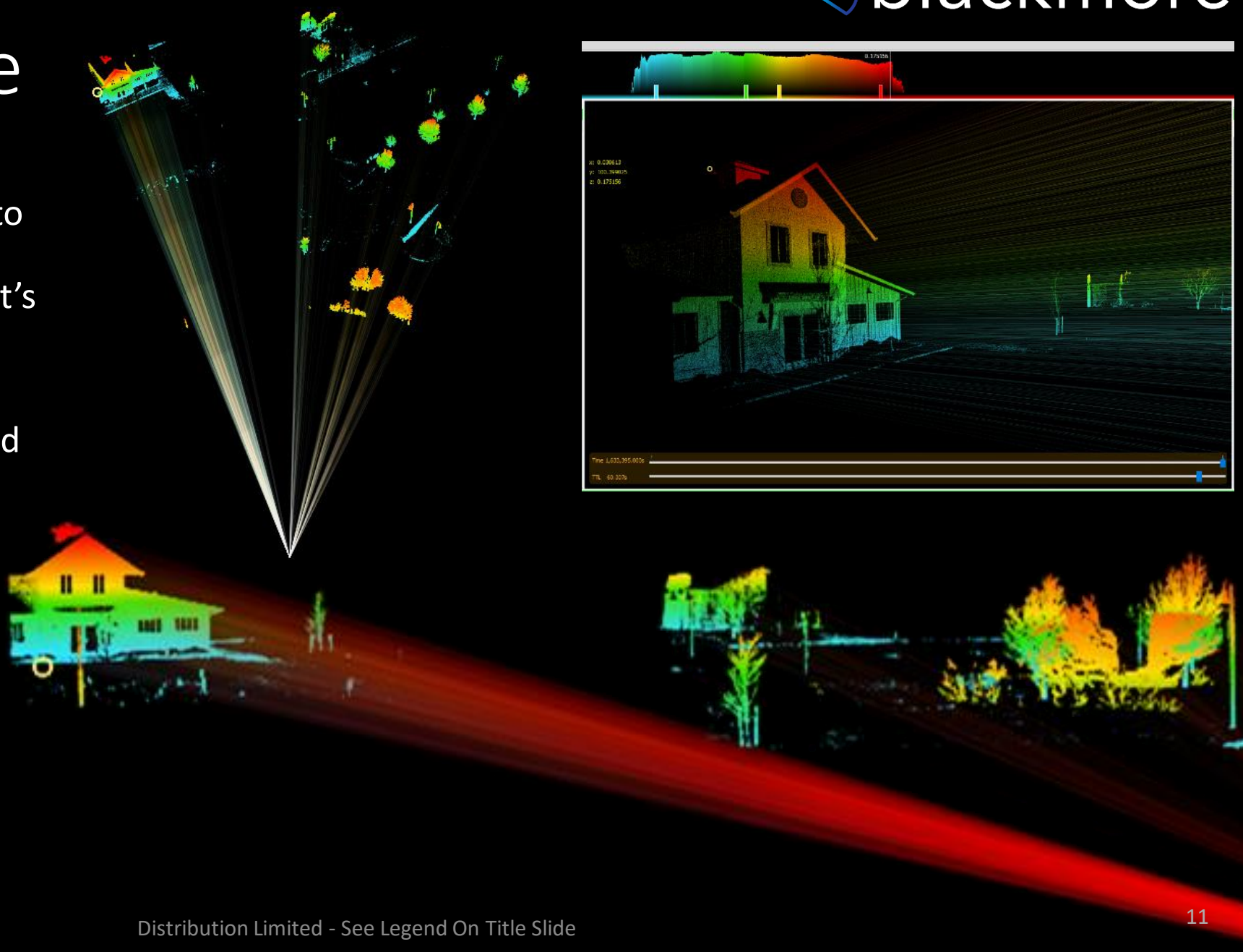






GUI Software

- Experimenting with ways to indicate the scanner's location in the scene and it's current view.
- This should give more perspective to the data and will also help when interfacing with multiple scanners.
- Also could be used to highlight features, movement, etc.



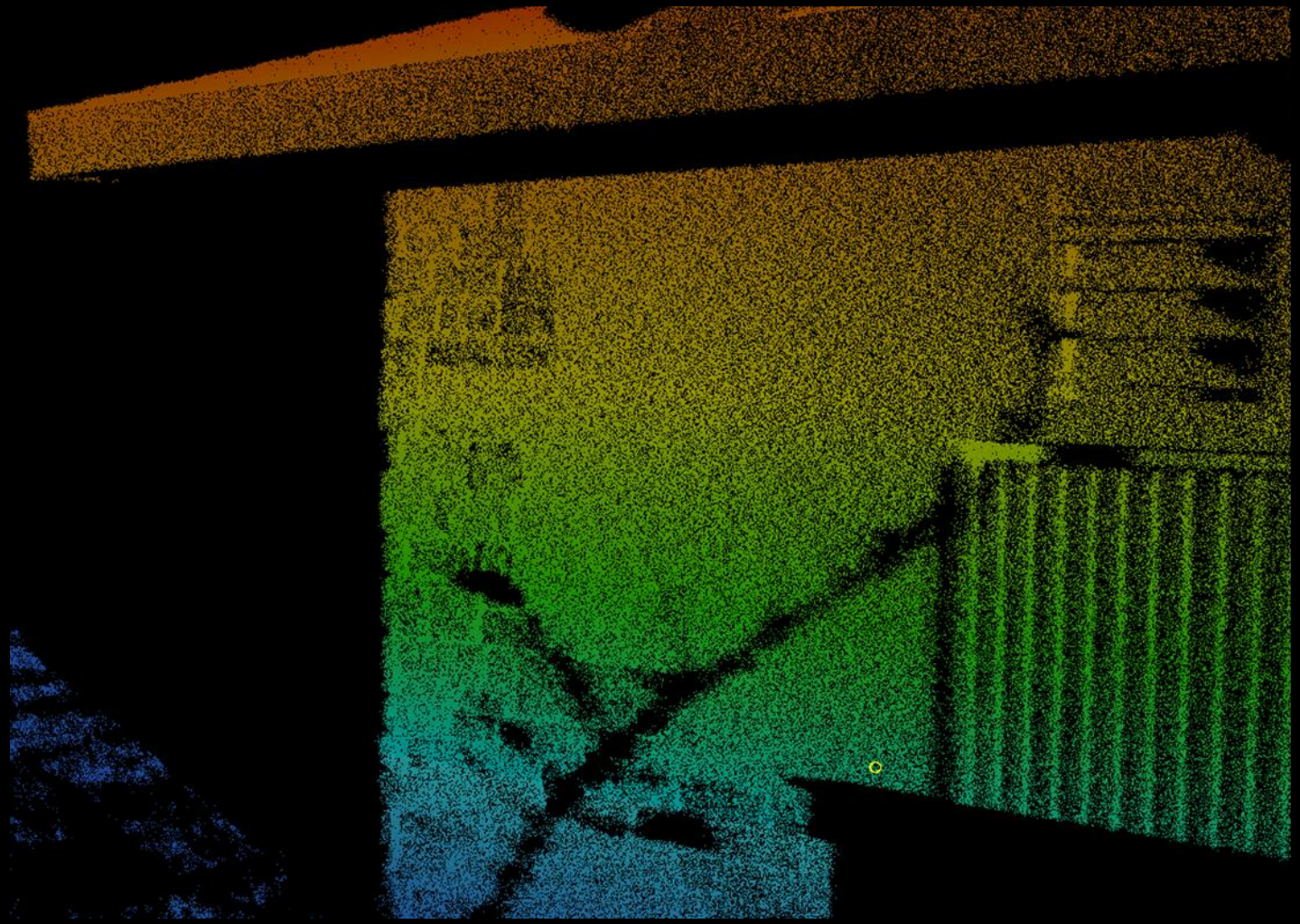
Sensor Fusion

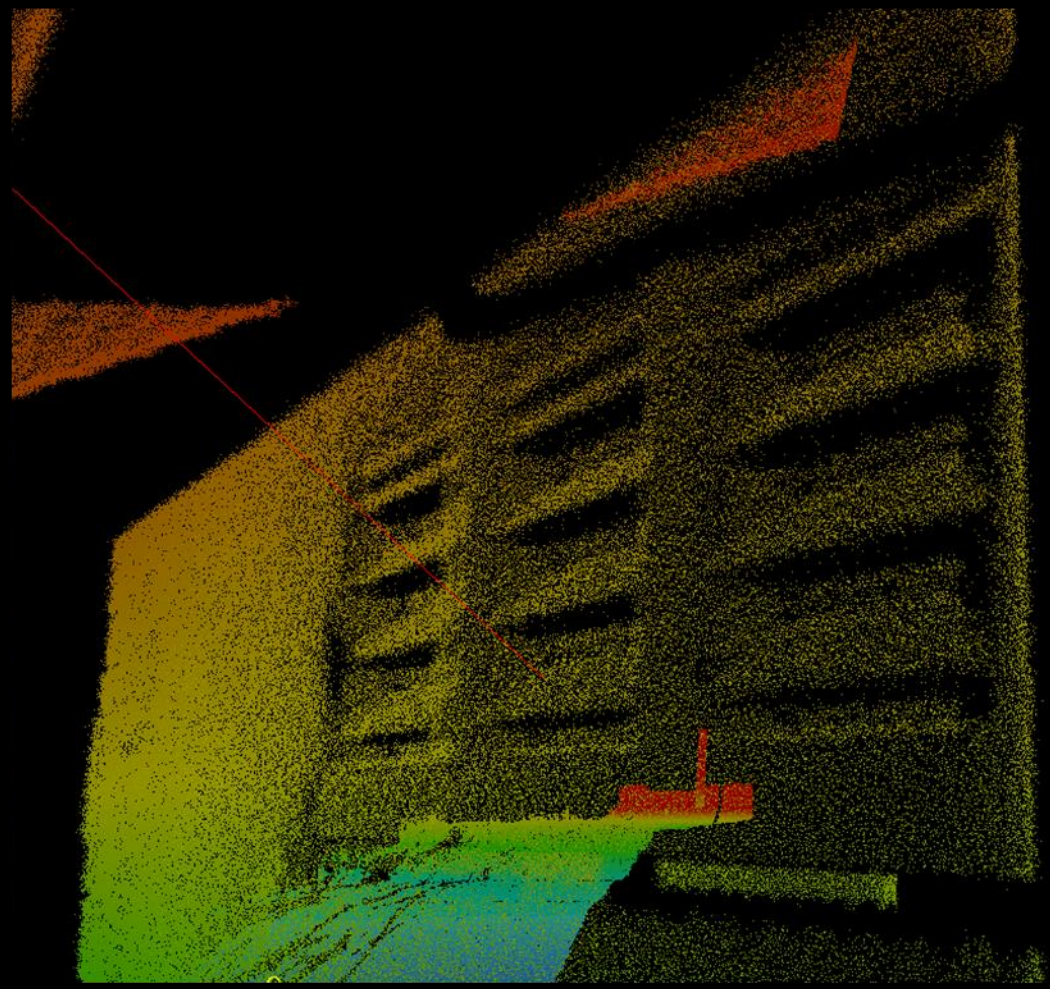
RGB Overlay Data

Data and Results

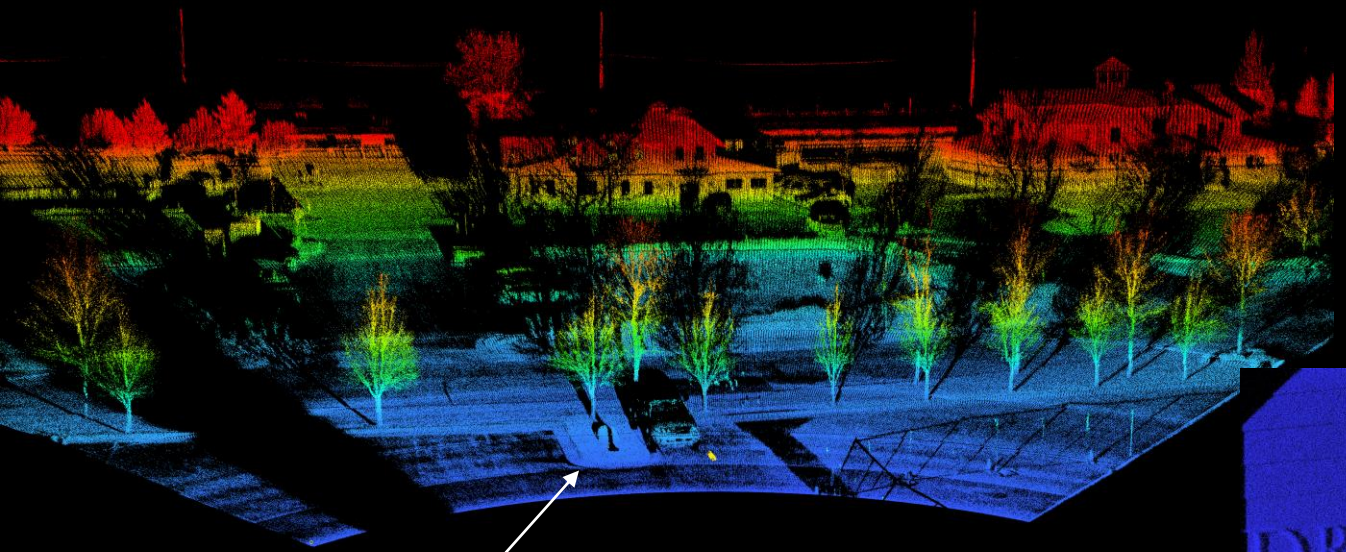
High Quality 3D Imagery

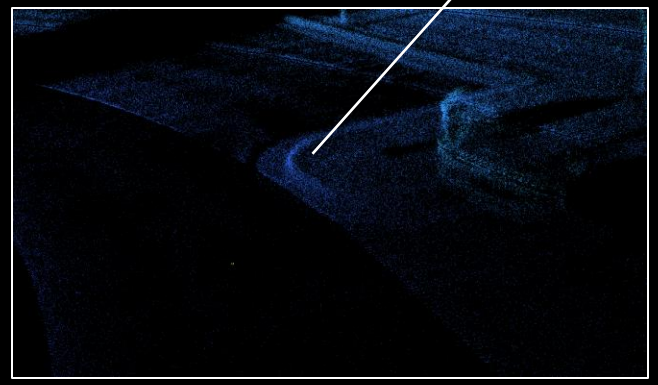
Example Imagery





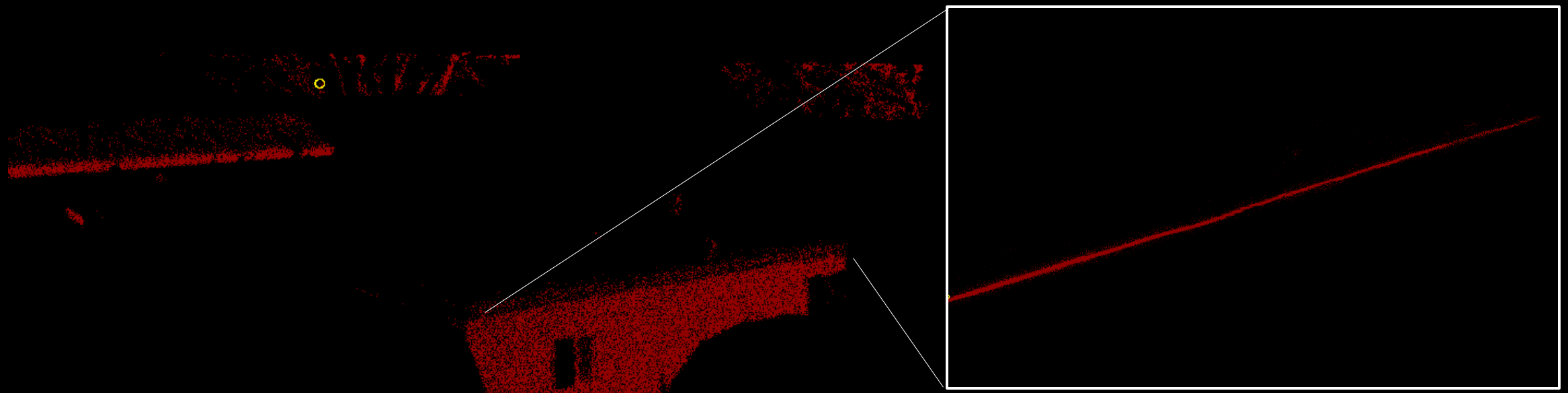
Example of Base Map Mode and Point And Click Functionality





Dentist Office Sign

Long Range Imagery



Example Imagery

Key Questions

Key Questions

- What ranges are expected?
- What is the range noise requirement?
- What is the cross-range resolution requirement?
- What post-processing is anticipated?