Program Final Report
PFR-3202

Aircraft laser strike geolocation system overview

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Lexington Massachusetts

Aircraft Laser Strike Geolocation System Overview

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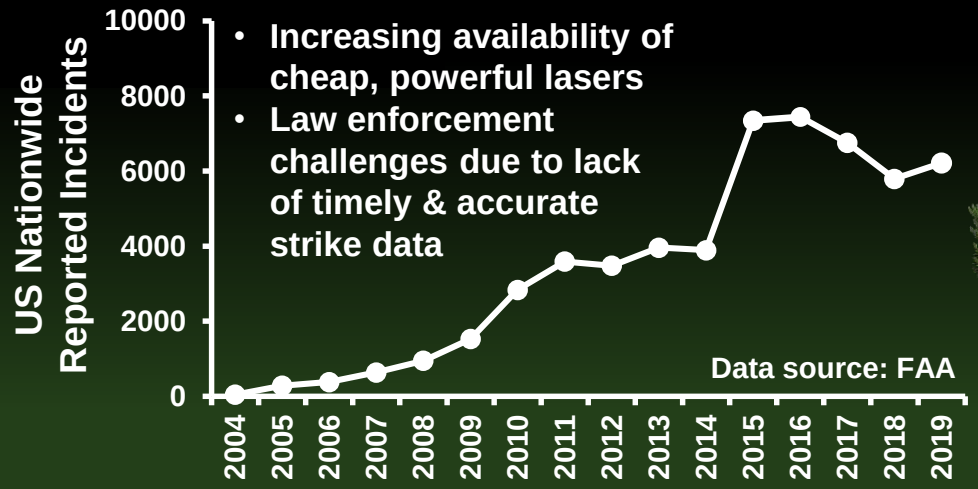
Continuing Laser Strike Threat to US Aviation

Laser can disorient pilot, degrade night vision or cause permanent injury. Safety & security erosion.



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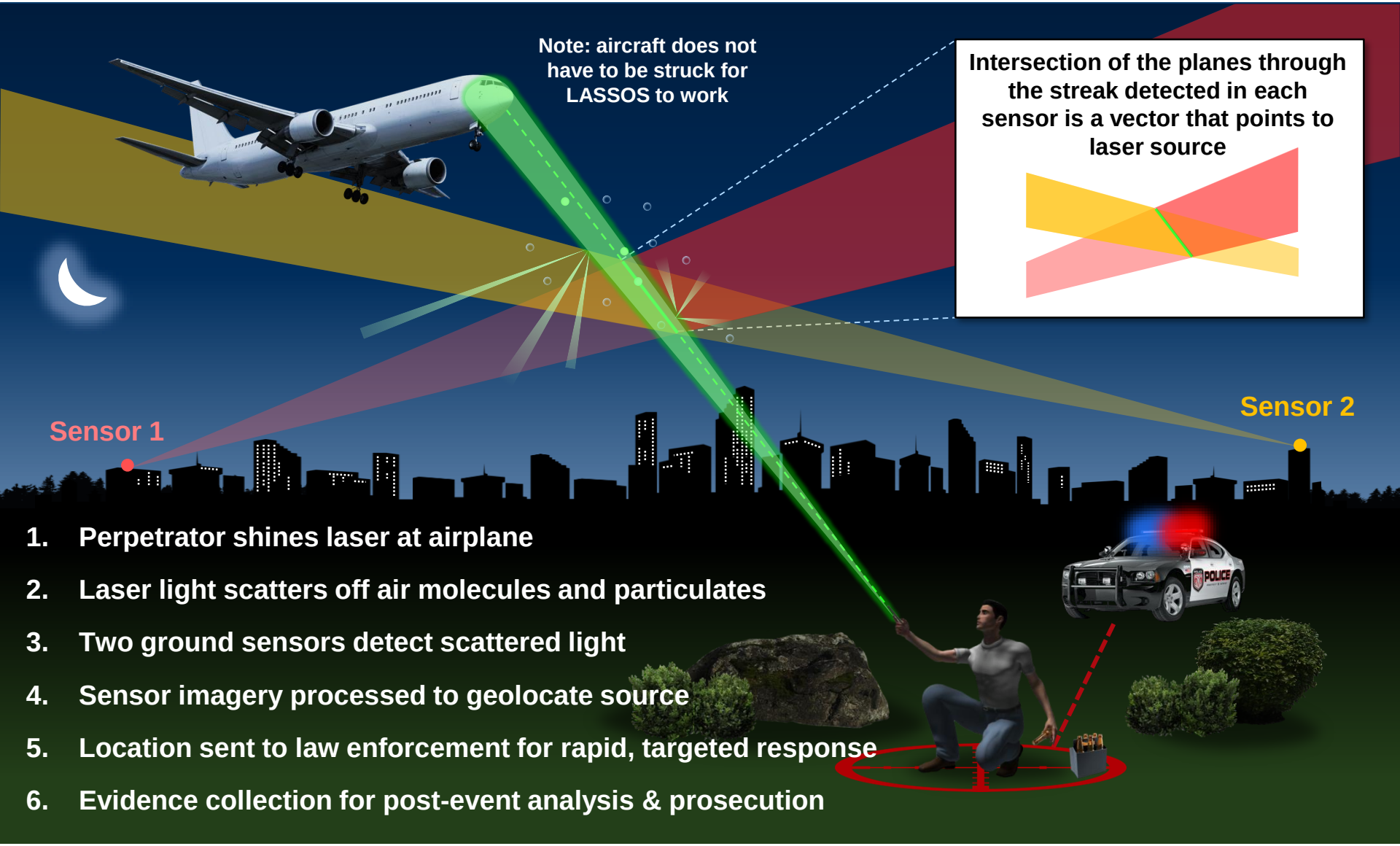
Laser Pointers Commercially Available Online

Laser Strike Mitigation Options

	Approach	Laser Mitigation Effectiveness	Pilot Effects	Technical Risk	Estimated Relative US-Wide Cost
POLICY	Legislation, Public Awareness Campaign	May encourage perpetrators	None	Available today	0-low (laws already exist)
HARDEN AIRCRAFT	Passive Glasses/ Goggles	Effective for common lasers	Reduces ambient light, pilot non-compliance	Available today	$100s millions (all certified pilots)
HARDEN AIRCRAFT	Cockpit Window Treatment	Effective for common lasers	Reduces ambient light	Available today	$billion (all commercial aircraft)
FIND PERPETRATOR	Airborne Geolocation Sensor	Effective only if aircraft struck	None	Available today (military)	$100s millions (police a/c) $billion (all aircraft)
FIND PERPETRATOR	Ground-Based Geolocation Sensor Network	No aircraft strike required	None	Demonstrated technical viability: needs operational demo	$10s millions (total for top 30 airports, individual airport cost $250k-750k depending on # sensors needed)

Need for ground-based sensor system to support rapid, targeted law enforcement response

Laser Aircraft Strike Suppression Optical System (LASSOS)



1. Perpetrator shines laser at airplane
2. Laser light scatters off air molecules and particulates
3. Two ground sensors detect scattered light
4. Sensor imagery processed to geolocate source
5. Location sent to law enforcement for rapid, targeted response
6. Evidence collection for post-event analysis & prosecution

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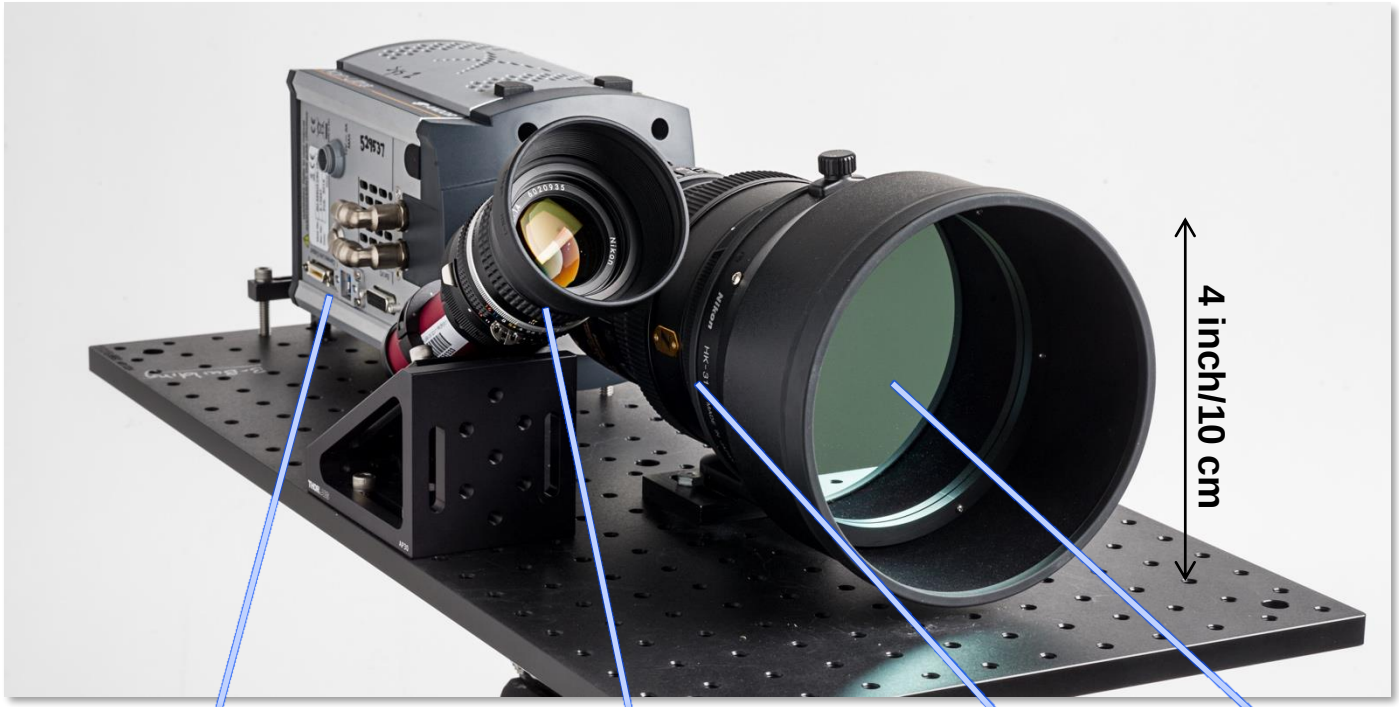
LASSOS Initial Sensor Prototype



Minimum enhancements for operational prototype

Power & Network Connections
- Enables long duration unattended operation
- Communication to centralized law enforcement command center

Rugged Enclosure
- All-weather operation

Real-time Processing
- For rapid geolocation estimates

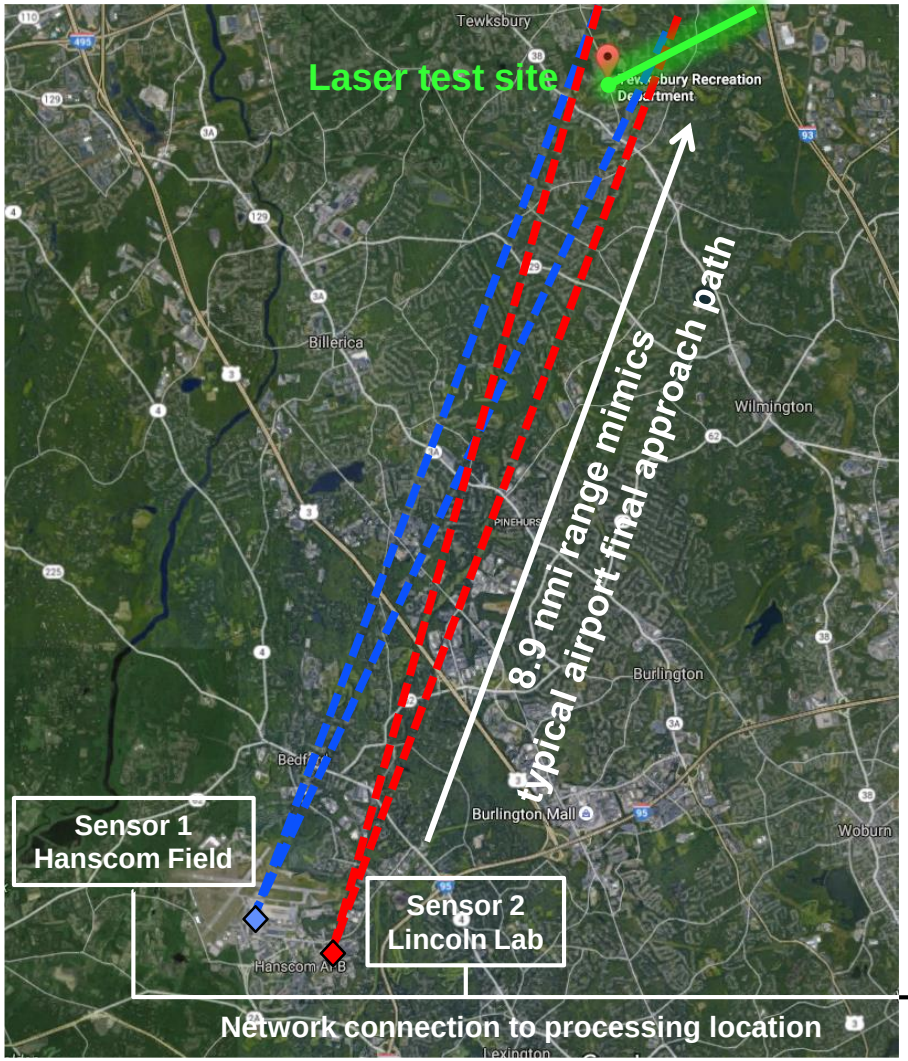
Camera
- Andor astronomy-grade cooled CCD camera
- Very low noise and high sensitivity (single photons)

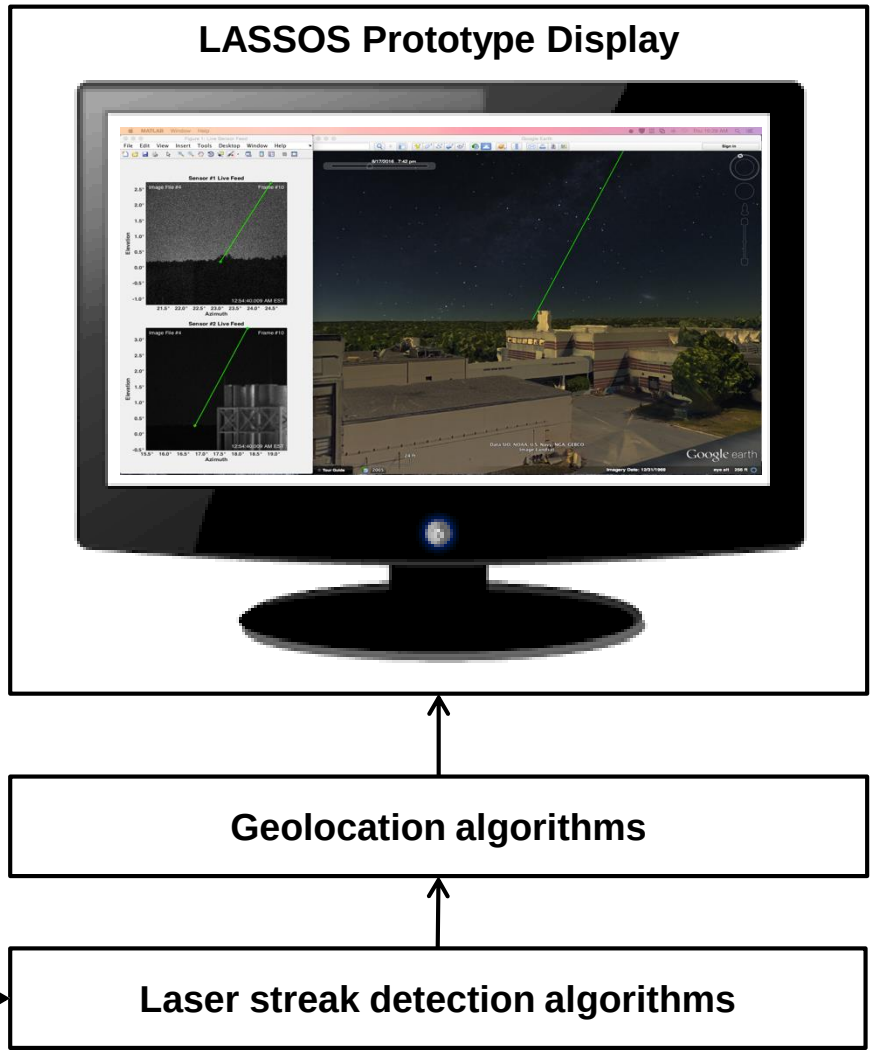
Star Tracker
- Kodak low noise CCD, Nikon lens
- For sensor attitude determination

Lens
- Large commercially available aperture (10 cm) to capture more light onto camera

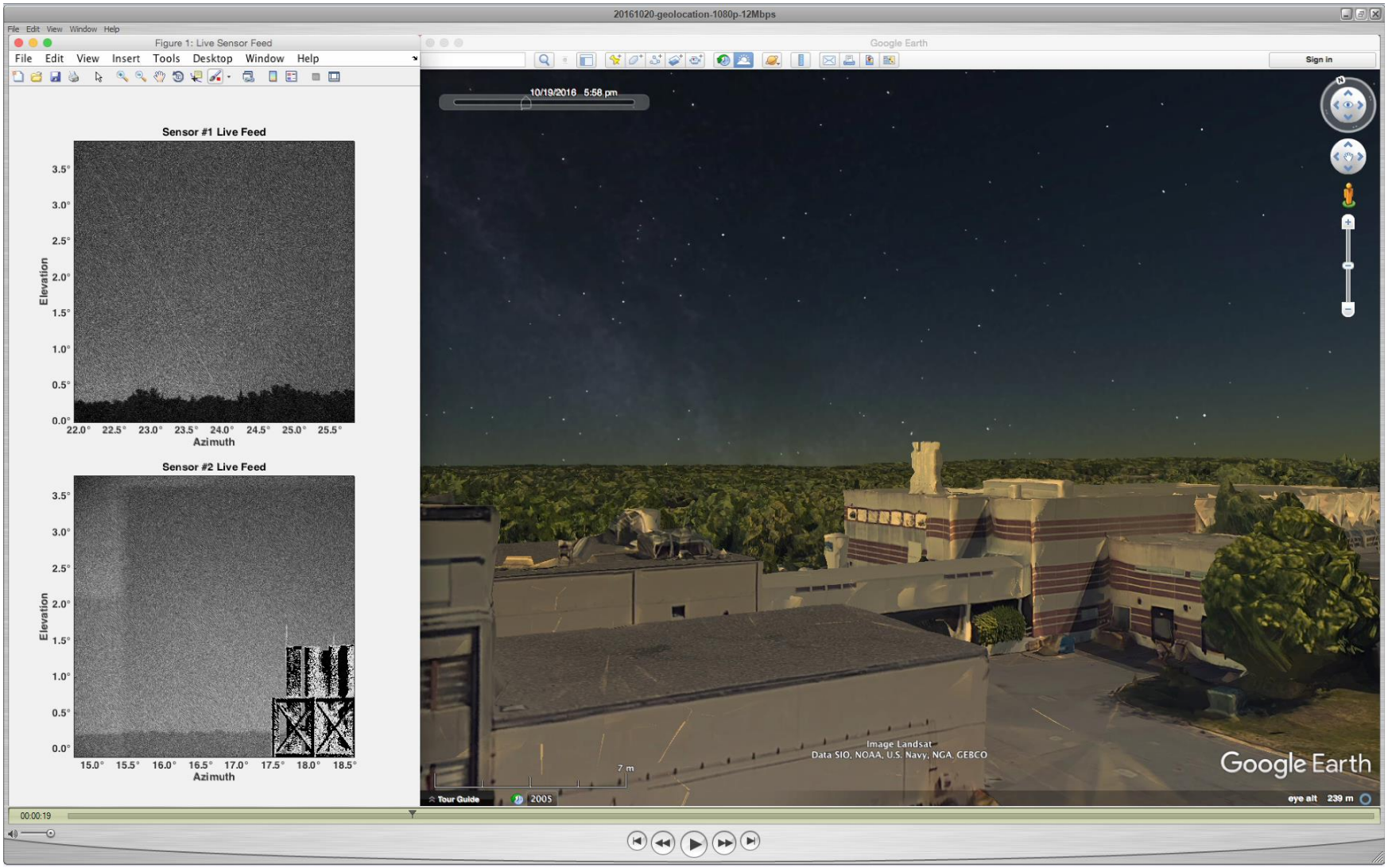
Filter
- Filter blocks all irrelevant wavelengths (e.g., sky background light), thereby lowering the noise in the image
- 94% US laser incidents are green

LASSOS Prototype Testing at Lincoln





LASSOS Prototype Testing at Lincoln



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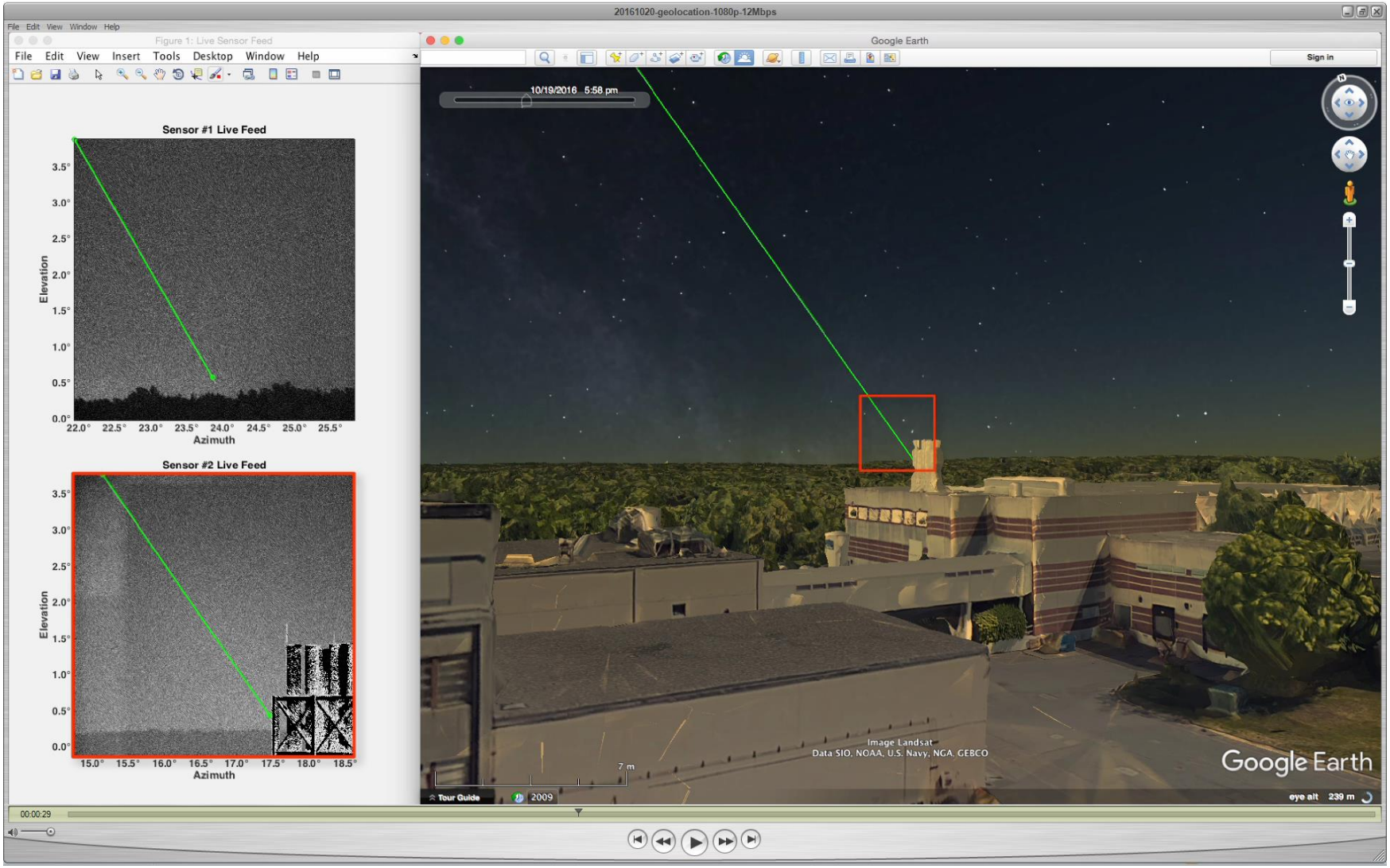

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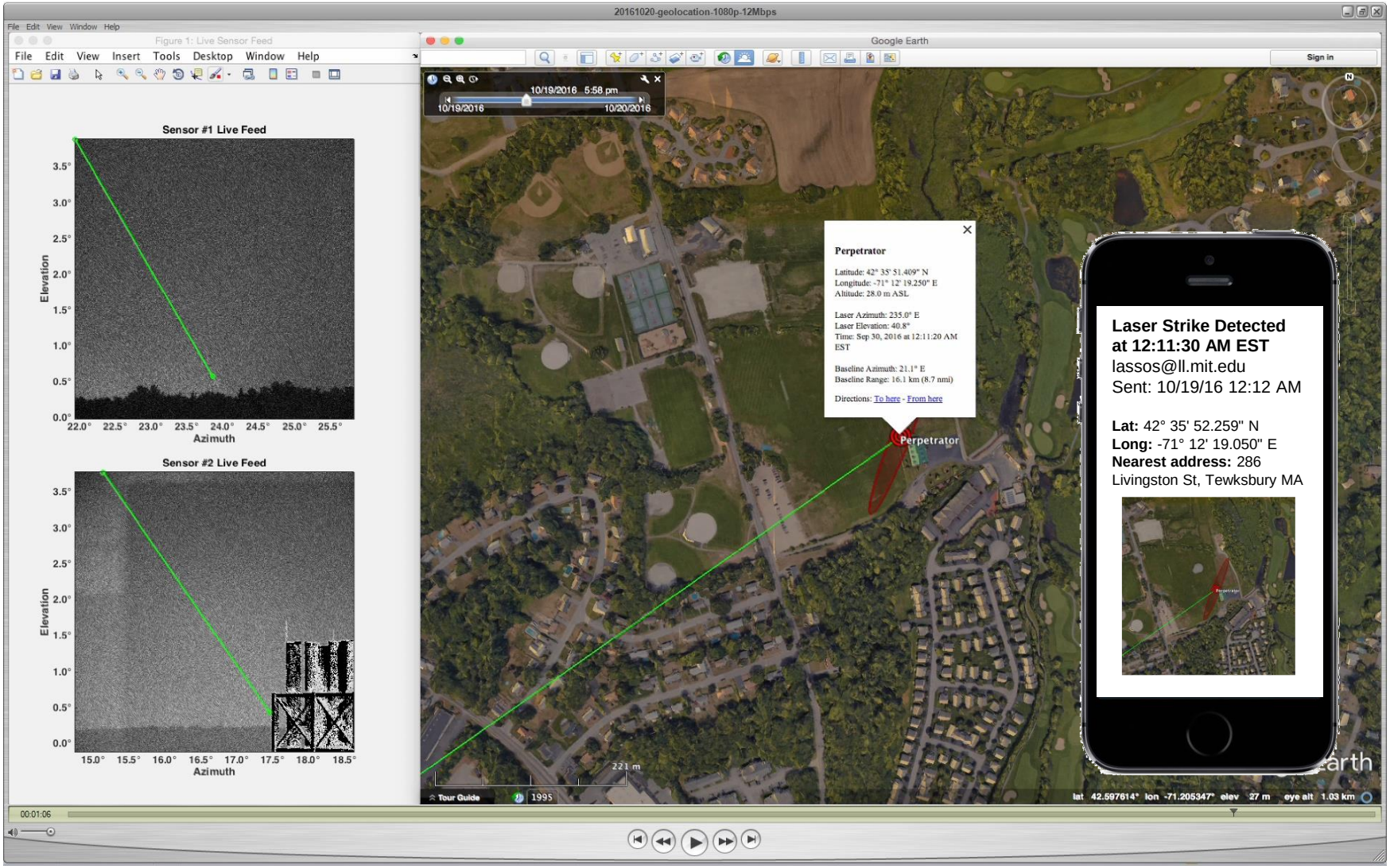

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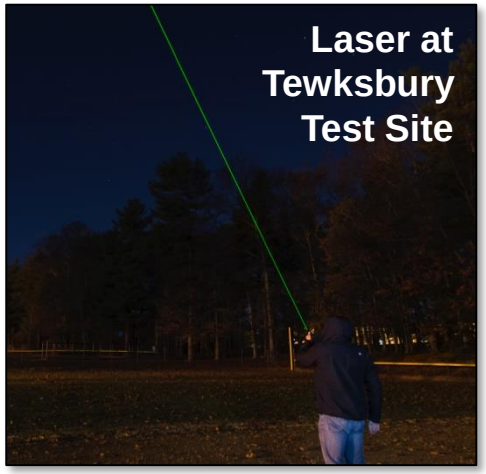
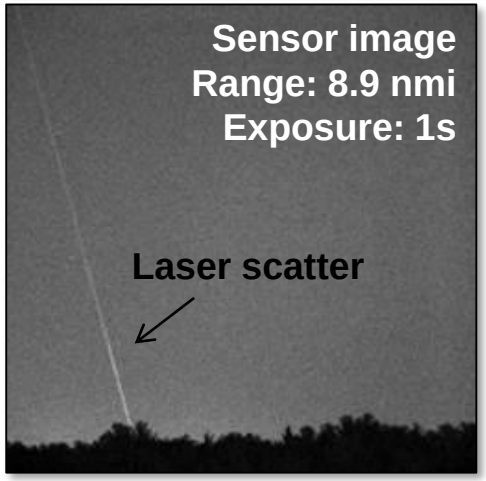
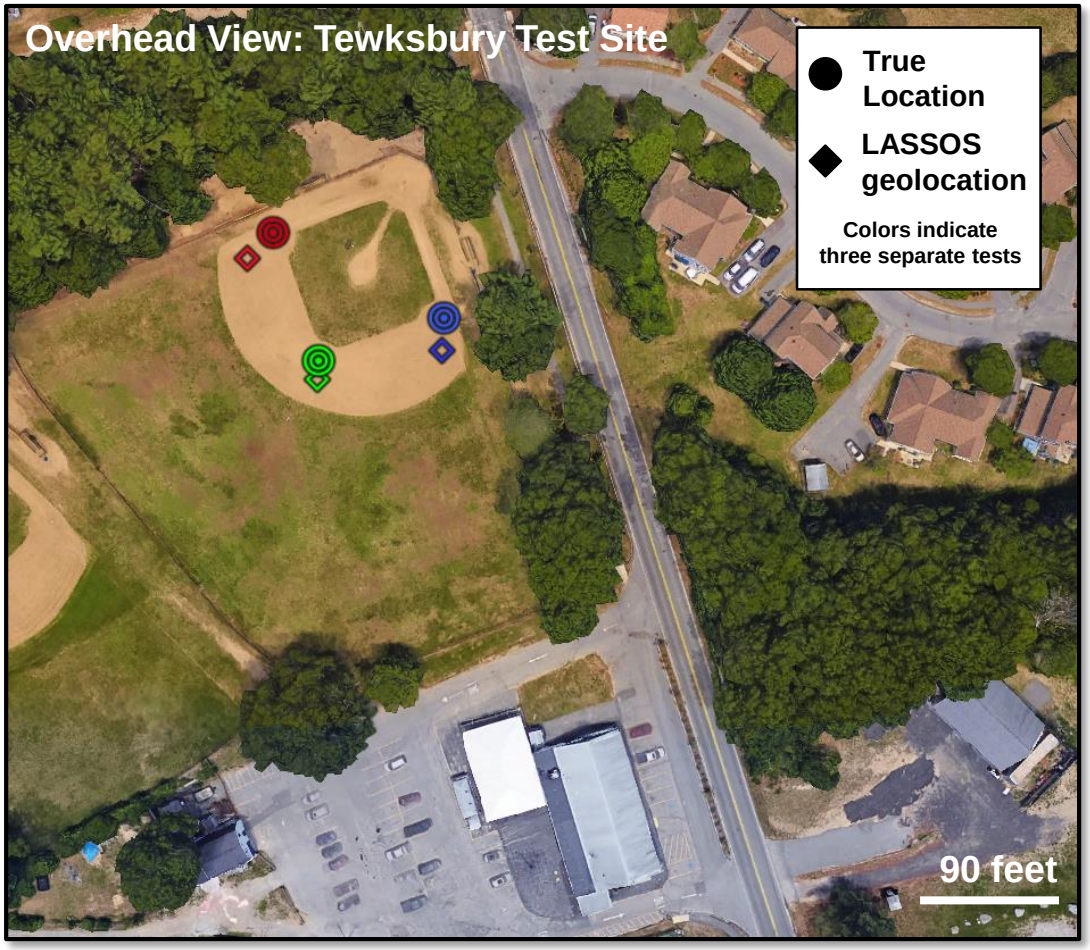






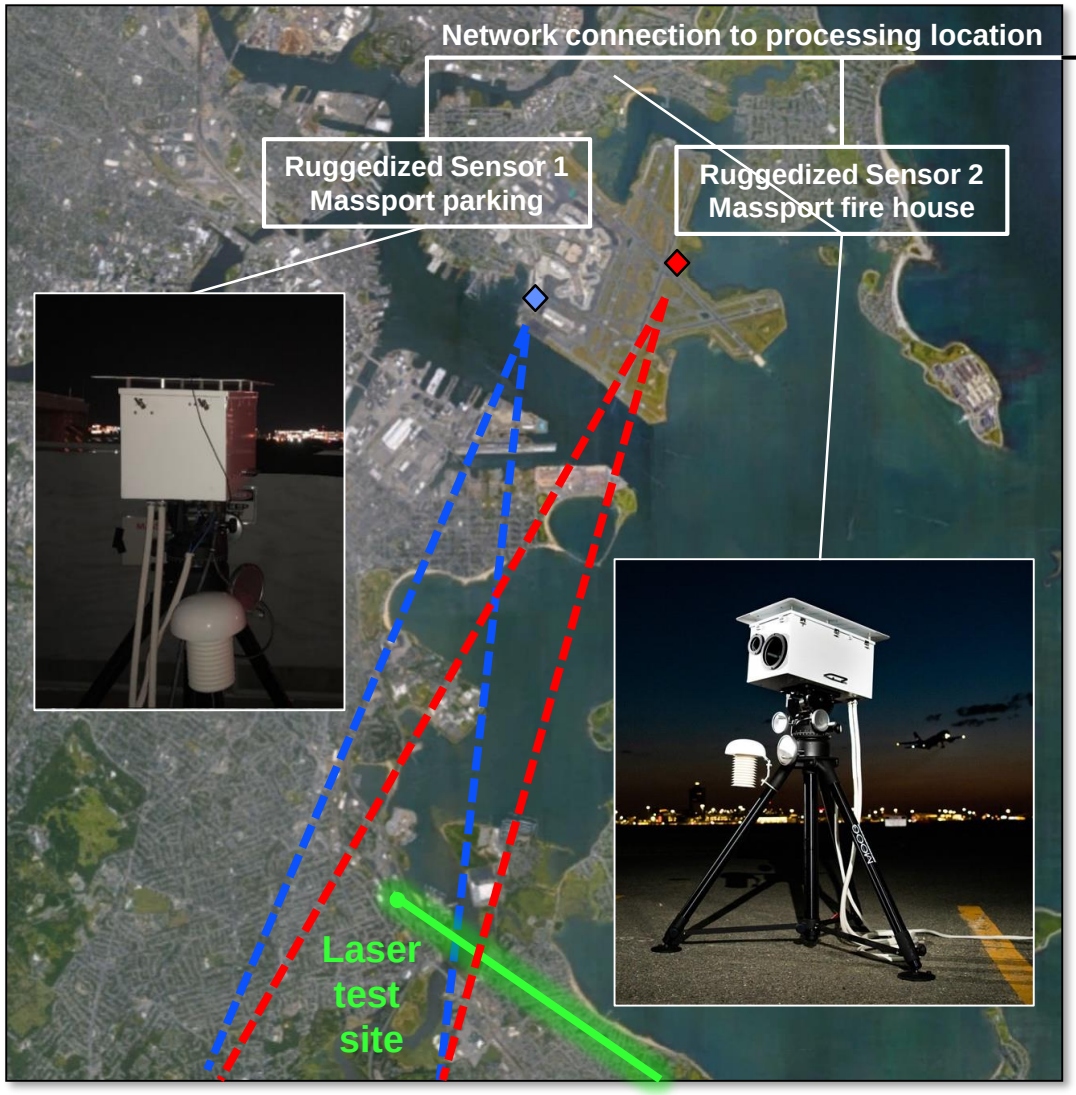
Geolocation accuracy <10 m (30 ft) at 9 nmi range within 15 secs

USAF Funded Program Objectives

USAF funding Lincoln to develop and demonstrate ruggedized, portable LASSOS for field deployment

- **Increase sensor field of view**
  - **Increase camera sensor size and/or decrease lens focal length**
- **Explore options for multi-spectral capability**
  - **Existing multiple filters → multi-line filters/wheel**
- **Environmental protection for sensors**
  - **Enclosures & cooling**
- **Develop/demonstrate software control of sensors**
  - **Camera control, image acquisition, calibration → more automation**
- **System integration & testing**

Ruggedized Sensor Testing at Boston Logan Airport



Laser streak detection & geolocation algorithms

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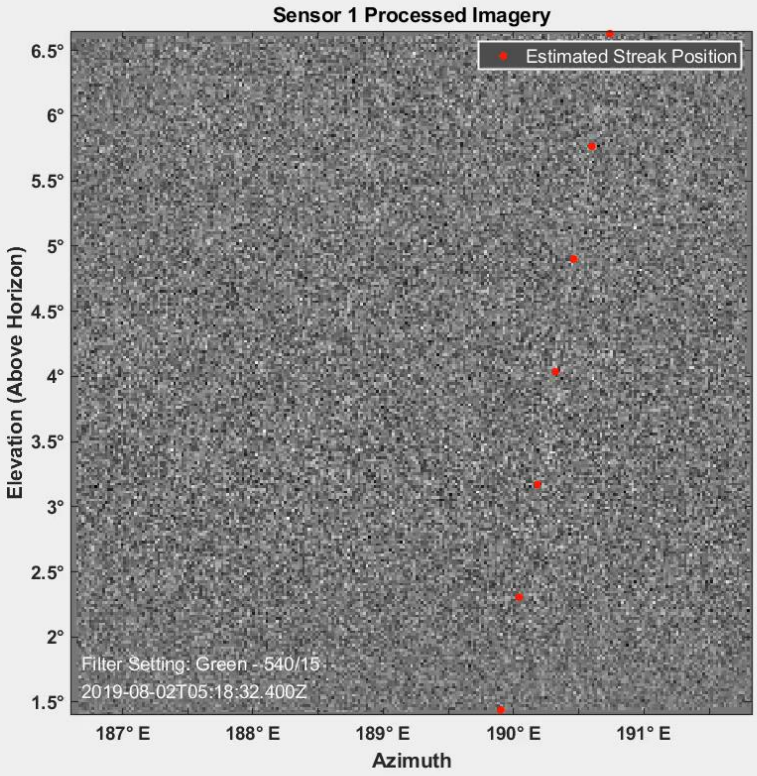
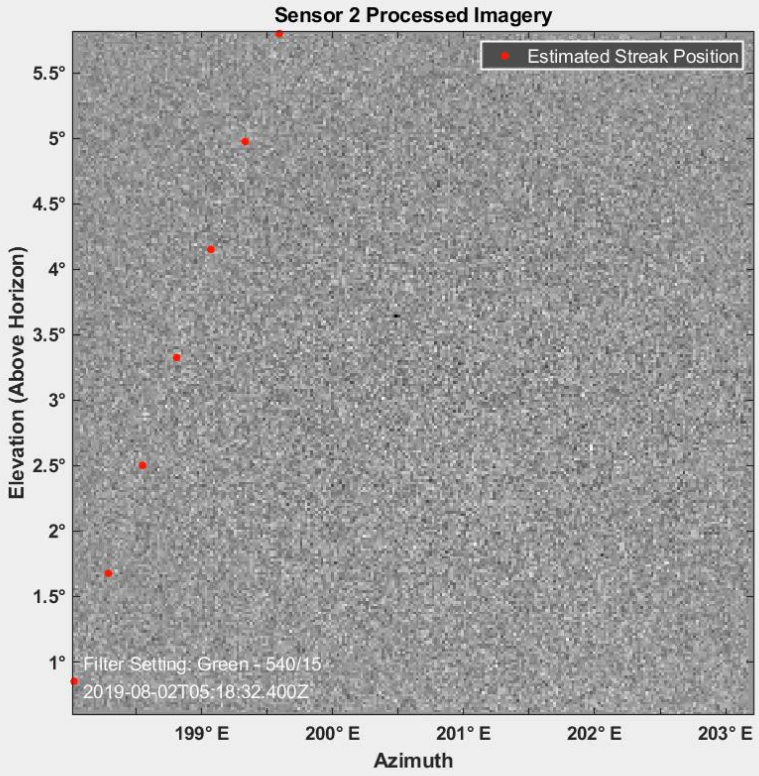
Post-event analysis

- Performed live laser testing at locations 5-7 nmi south of the airport
  - Tests conducted in early hours of morning when traffic was minimal
  - Conditions more taxing than previous tests (high ambient light background)
- Extensive support from Massport, MA State Police & Federal Aviation Administration

Ruggedized Sensor Testing at Boston Logan Airport

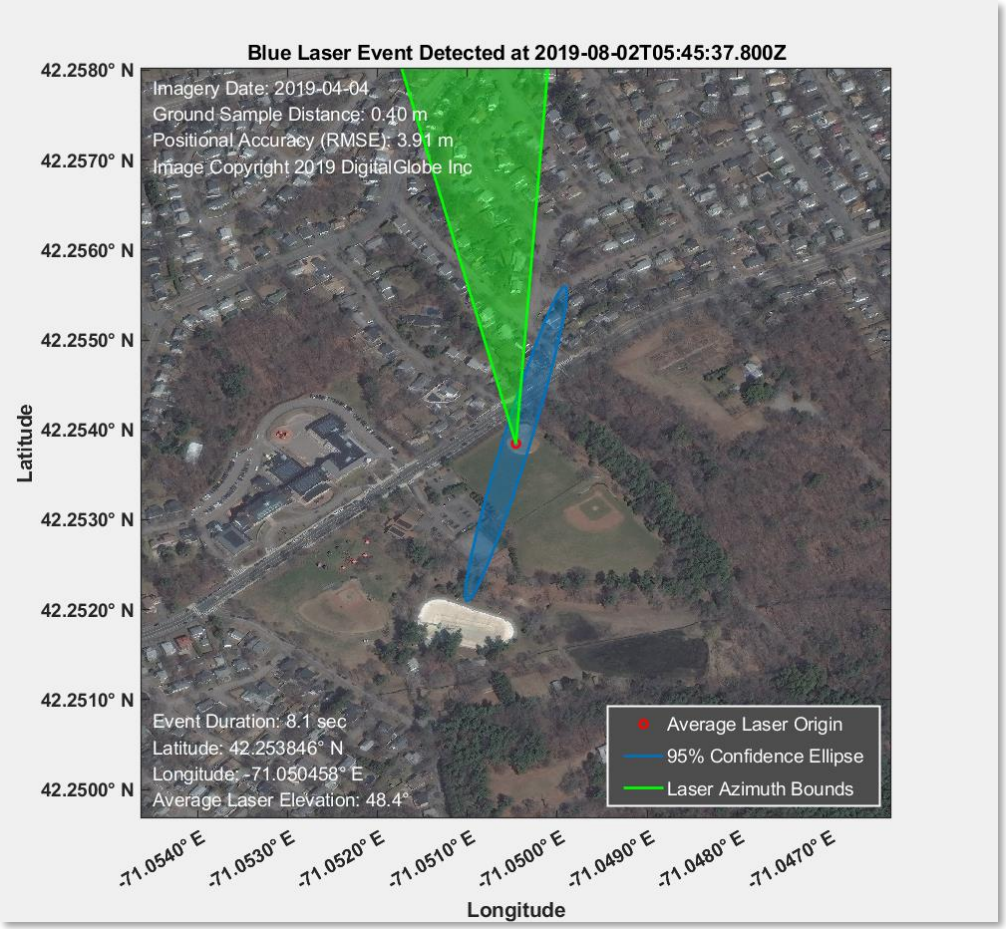




Demonstrates performance under low Signal-to-Noise Ratio conditions and 10 Hz updates allowing time domain analysis

Ruggedized Sensor Testing at Boston Logan Airport

- **Successful laser streak detections at all test sites (5-7 nmi range)**
  - **Green & blue lasers**
  - **Some detections depended on laser streak orientation relative to sensor**
- **Similar geolocation accuracy as Lincoln tests**



Demonstrates viability of LASSOS system in operationally realistic conditions

Summary & Planned Next Steps

- **Prototype ground-based laser strike geolocation system developed**
  - **Current testing shows very promising results (<10 m geolocation accuracy in less than 15 secs)**
  - **Operational airport testing confirms viability in field conditions**

- **Seeking to conduct longer term deployment, testing and refinement at US airport location**
  - **In discussions with FAA, FBI & airport authorities about support**
  - **Keen for new stakeholder engagement**

- **Ultimately plan to transition to federal government or industry for widespread deployment**

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Questions