



Moving Vehicle Characterization With Ultra Wideband (UWB) Radar

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Acknowledgements:

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LLNL MIR group
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Pat Welsh

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Application Scenarios



Potential sponsors at DOD (Army, Navy) and DHS have interest in automated detection, characterization, and assessment of vehicle traffic. (trains, trucks, tanks, autos, etc.)

Topic Areas:

1. Project Goals and Restrictions
2. Sensor Selection and Descriptions
3. Sensor Testing and Performance
4. Data Collection
5. Data Analysis



Project Goals

Sensor Readings

Signal Processing

- Presence of a target (train or automobile)
- Direction of target travel
- Speed of target
- Location of target (lane/track of travel)
- Target car count (train)
- Vehicle/train car identification



Project Restrictions

- Low power, battery operated
- Rapid set-up
- Remote data processing and/or exfiltration
- Operate in a variety of weather conditions and times of day
- Standoff from road/tracks
- Low cost, disposable



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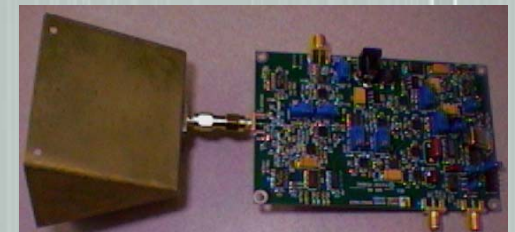
UWB is the optimal choice

Sensor Options and Comparison

	Operation	Data Complexity	Weather	Cost	Lifetime
UWB Radar	Easy	Reasonable	All	Low	Long
Camera	Difficult	Difficult	Clear, Day	High	Short
Magnetometer/ Geophone	Difficult, no standoff	Reasonable	All	Low	Long
Optical beam	Difficult	Reasonable, insufficient	Clear	Medium	Medium

Red - Unacceptable

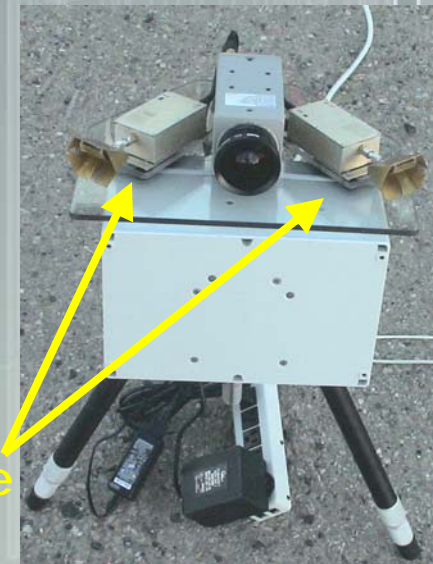
Yellow - Meets all requirements



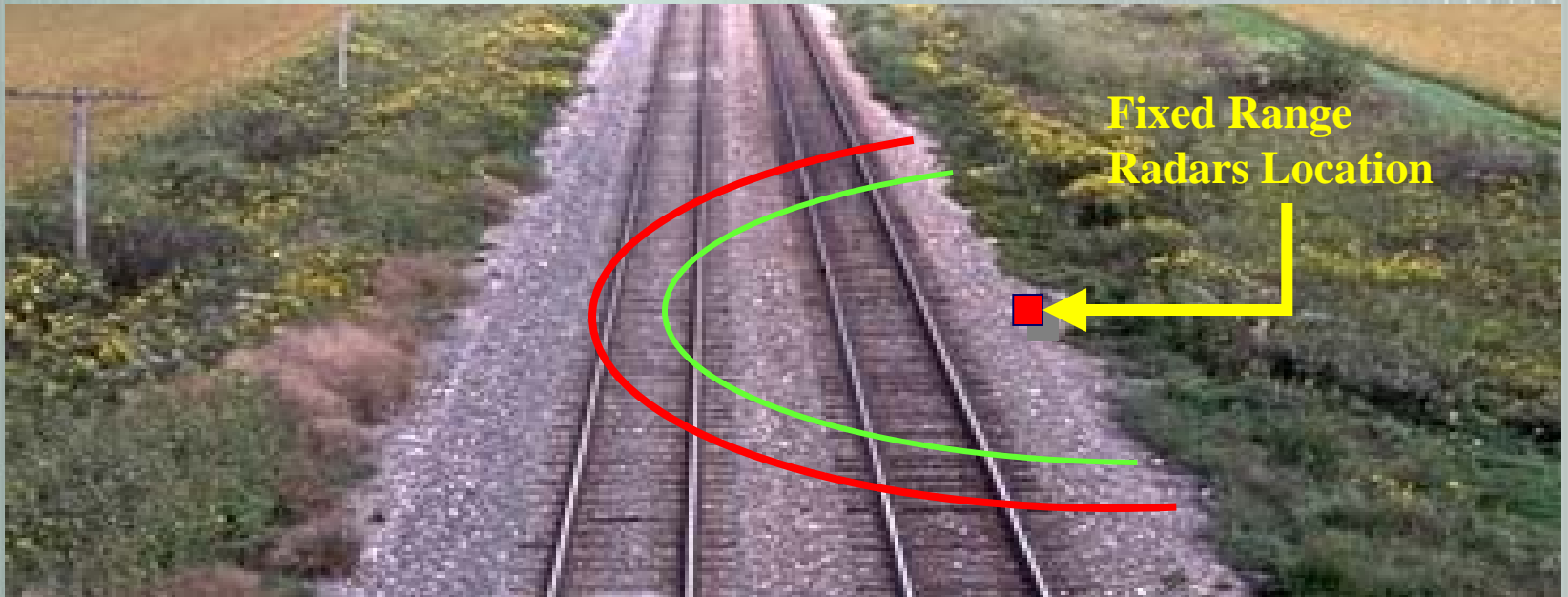
Data Collection, Fixed-Range

- Fixed-range sensors look for motion at a specific distance from the sensor
- Two are combined to measure target speed and direction

Fixed-Range
Radars

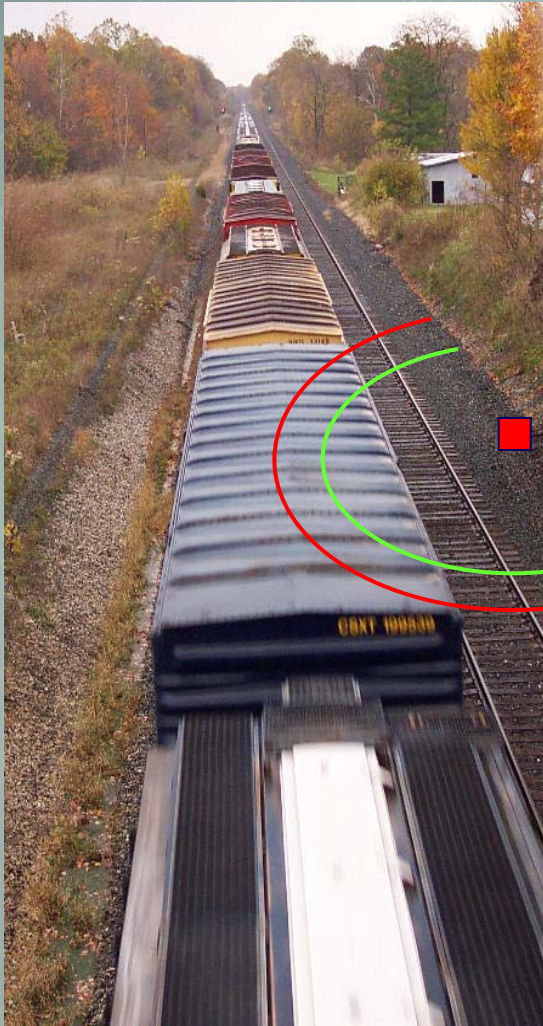


Fixed Range
Radars Location

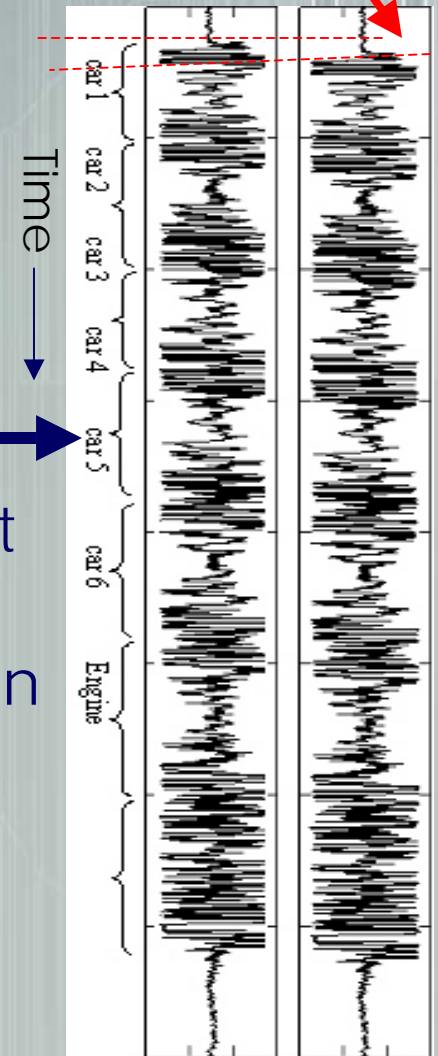


Fixed-Range Analysis

Fixed-Range radar time series provides: Velocity



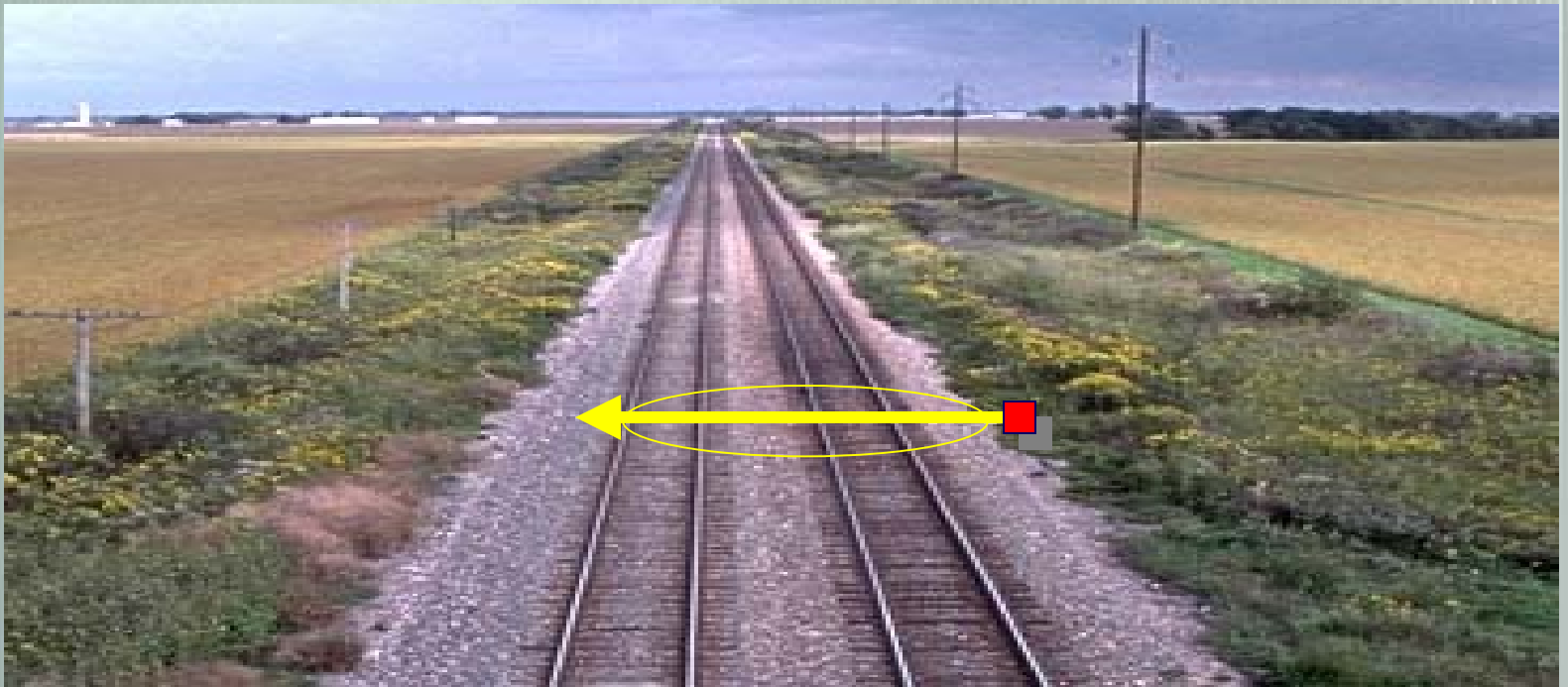
- Low power target detection
- Velocity measurements
- Potential car count
- Some discrimination information



Data Collection, Swept-Range

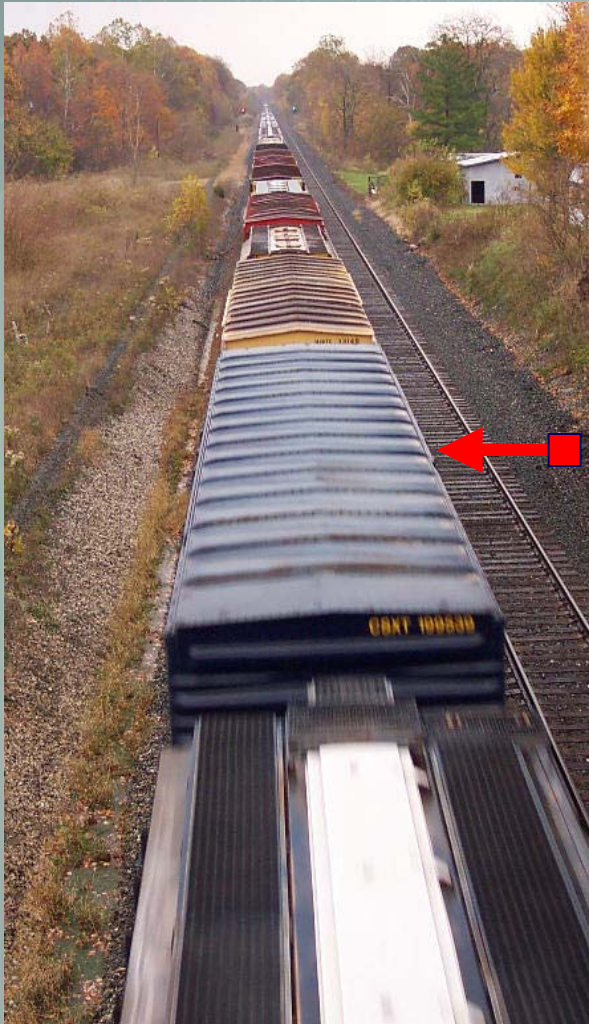
- Swept-range radar act like a type of range finder, giving radar reflectivity as a function of distance
- Profiles the side of the target

Swept-Range Radar



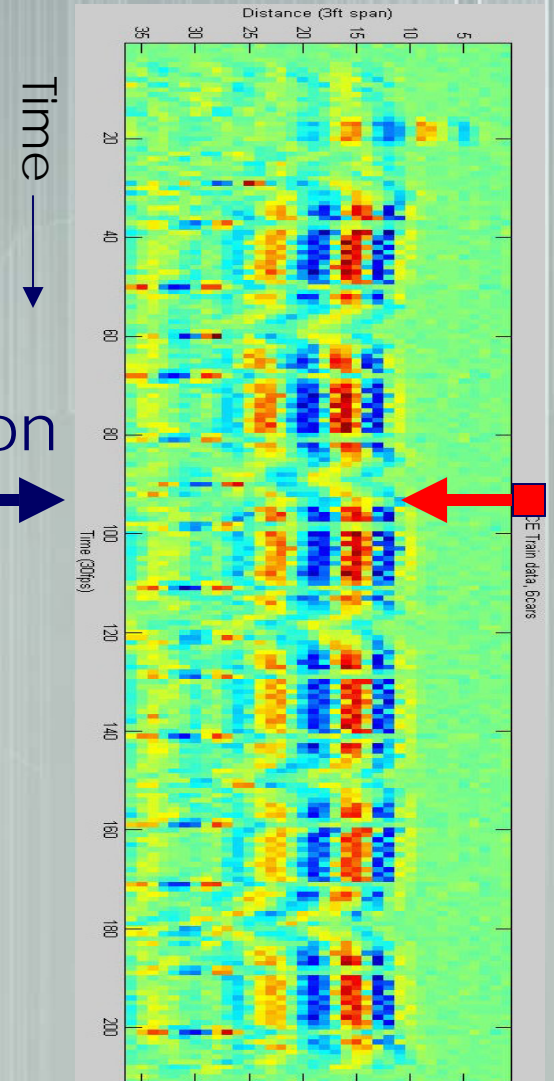
Swept-Range Analysis

Swept-range radar estimates:



- Detection
- Car count
- Discrimination
- Location
- Speed *
- Direction *

* using 2 radar

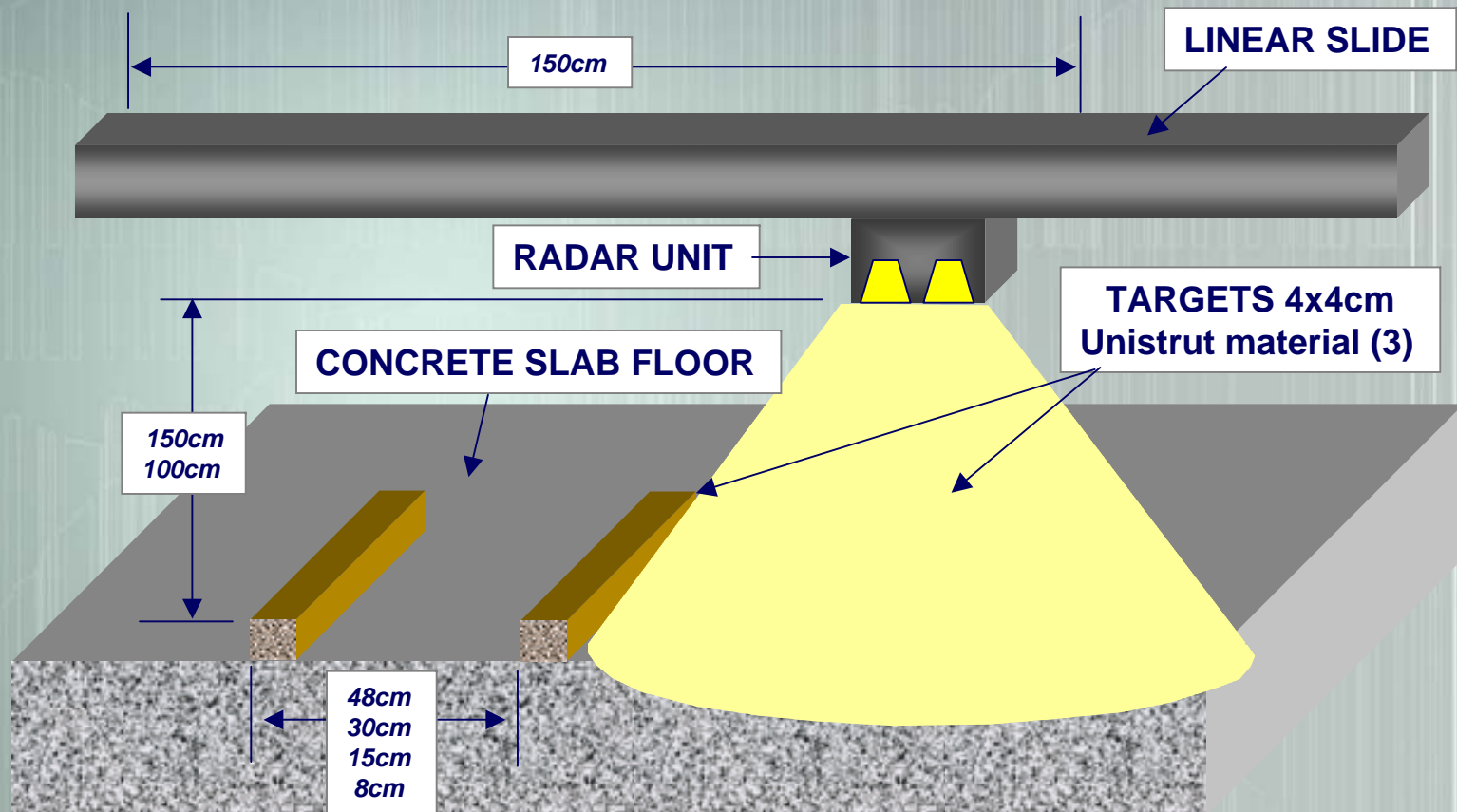


Topic Areas:

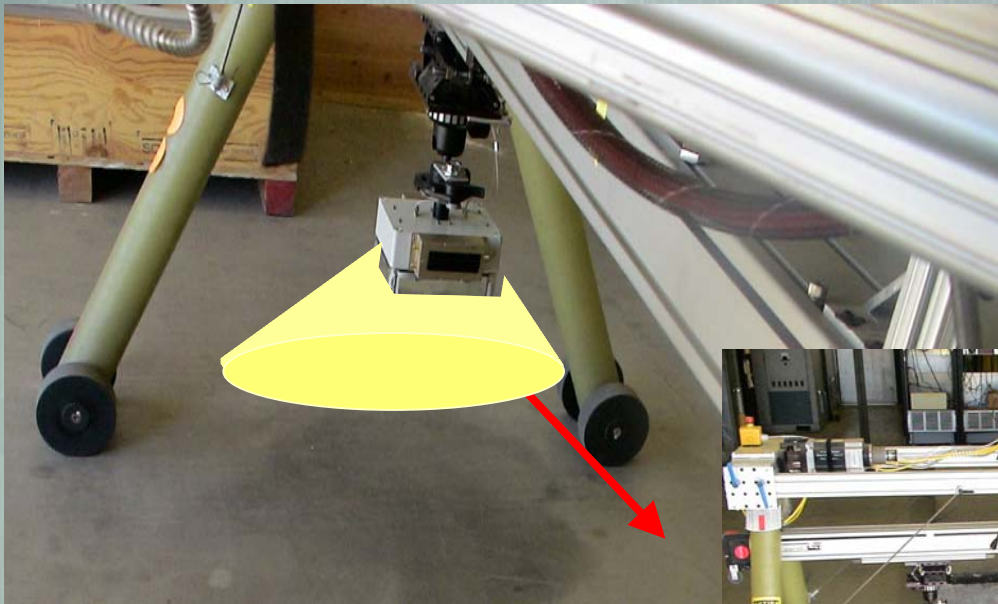
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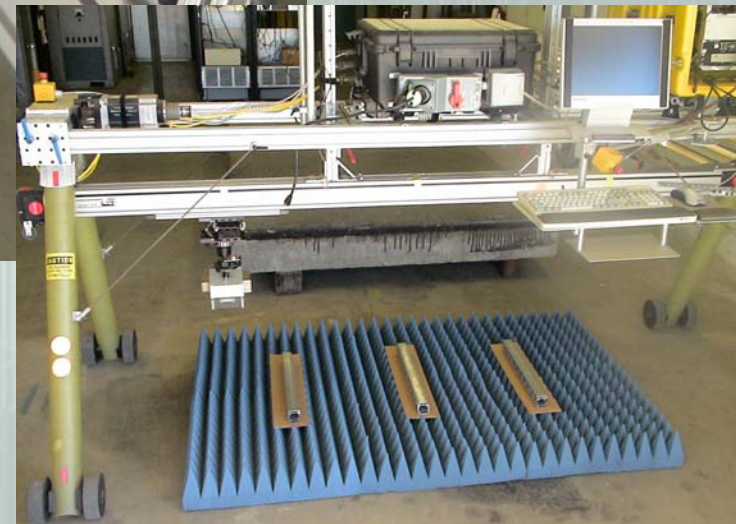
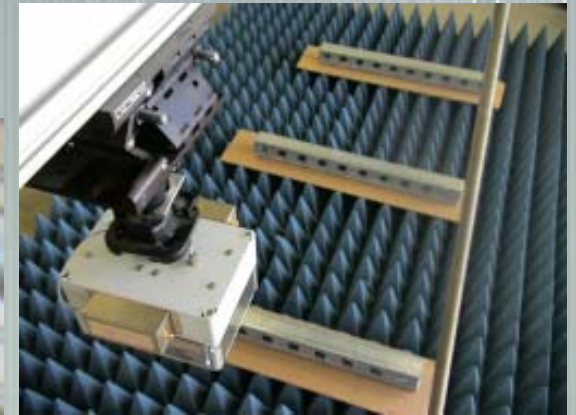
Diagram of experimental setup



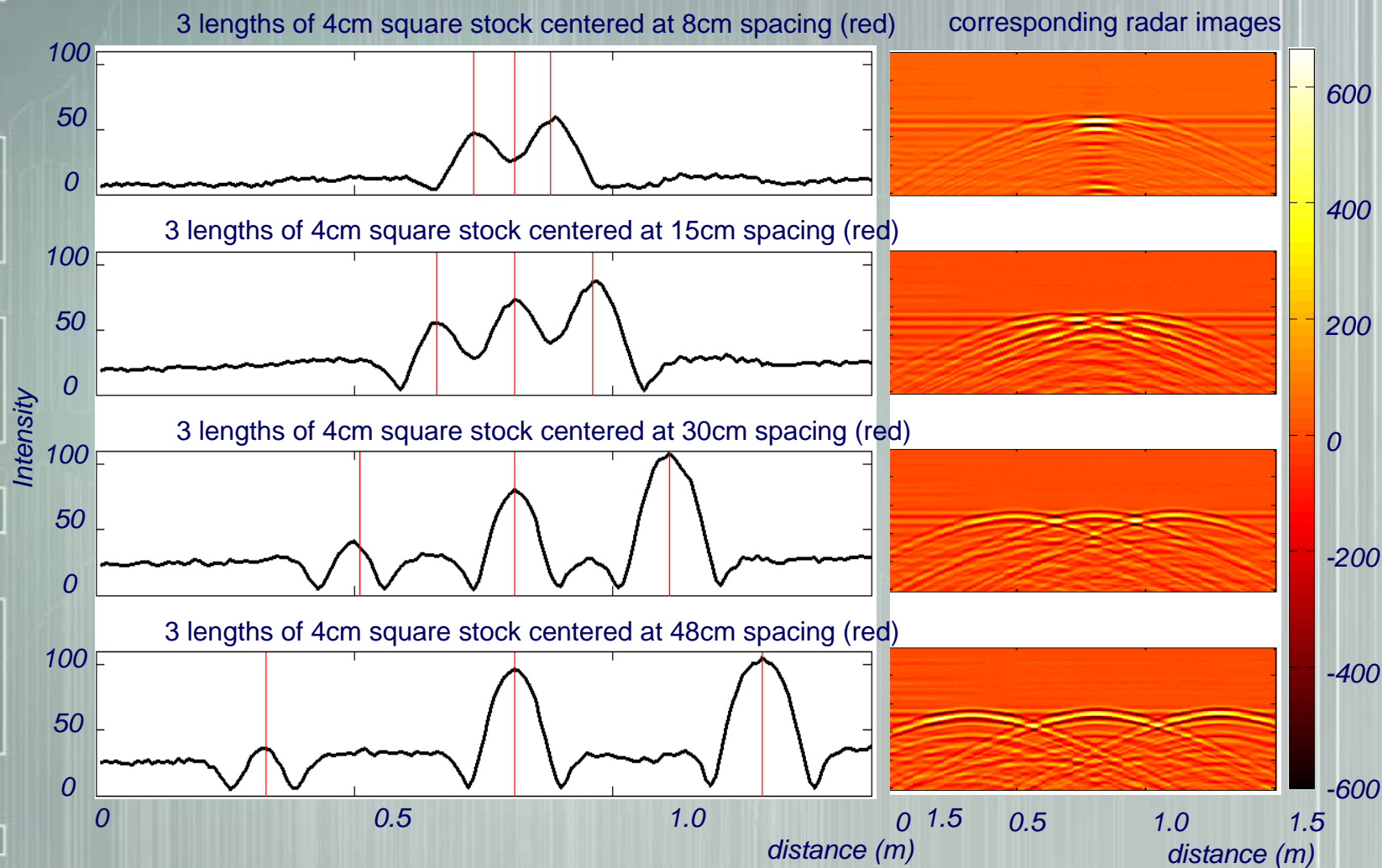
UWB Radar performance evaluation and verification test



Radar tested by scanning a series of metal targets while the heights and distance between the targets is increased



Analysis of the swept-range sensor data



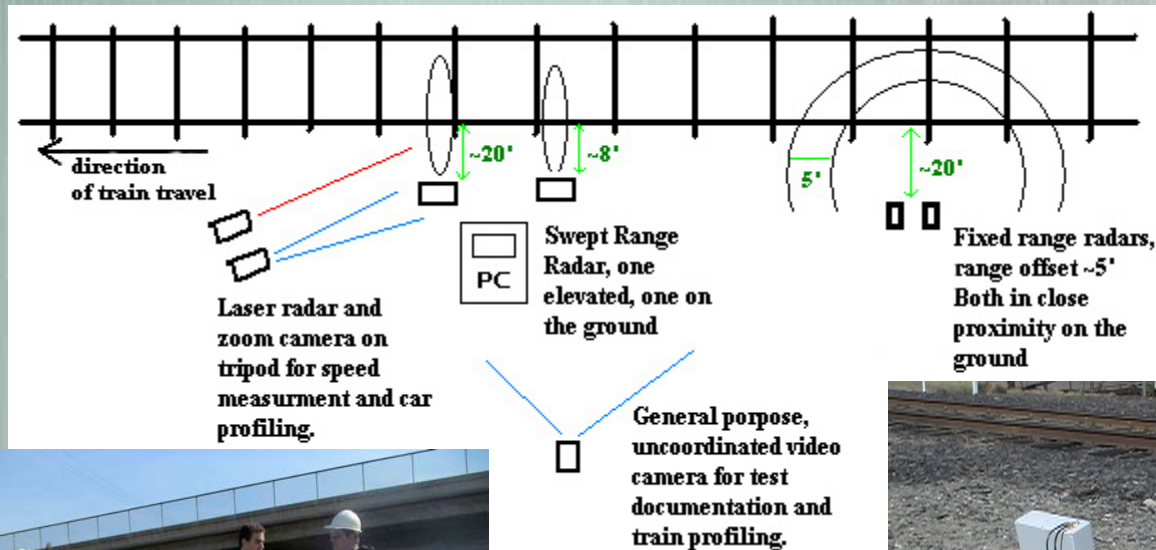
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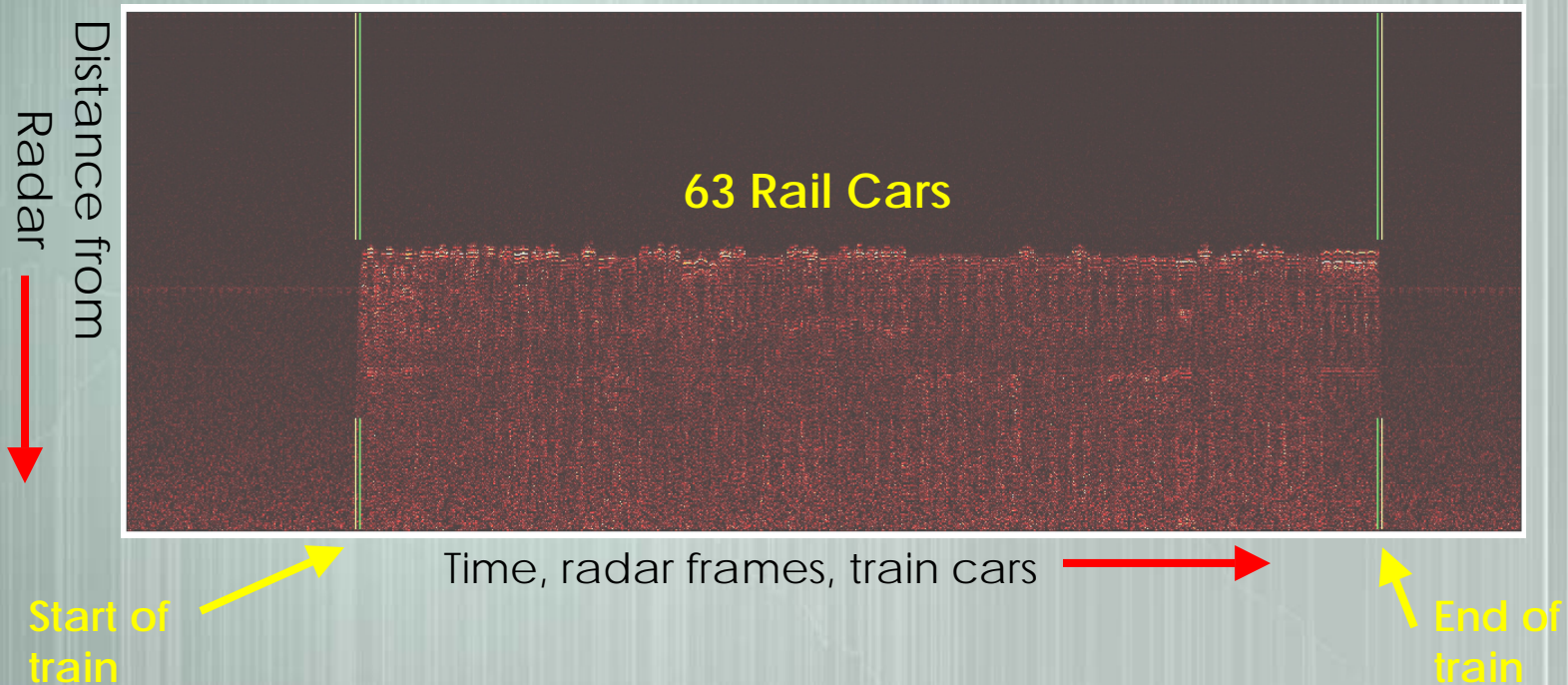
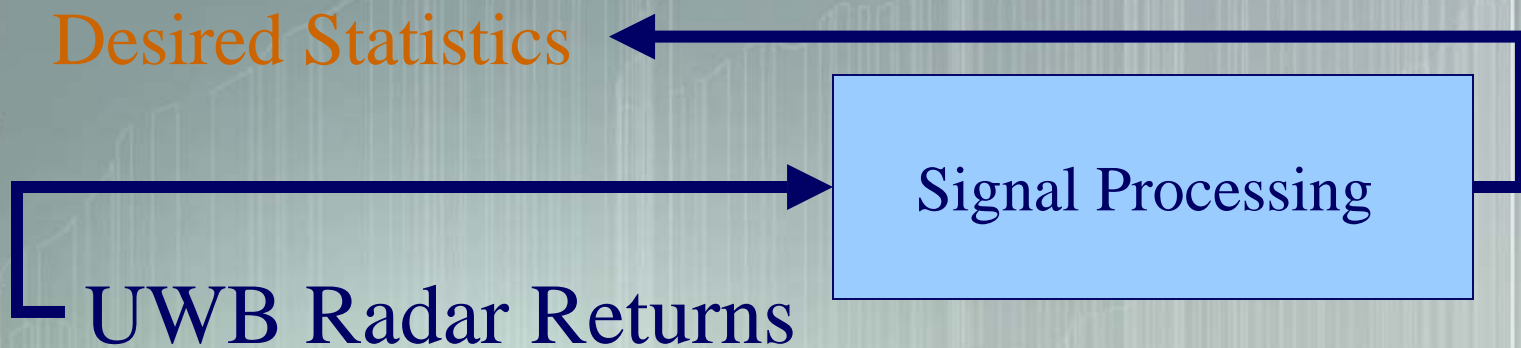


Deployment Setup

Cameras and Speed Radars were used in data collection to validate the sensor measurements and provide ground-truth for the signal processing



Deployment Data Results



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UWB Radar Returns

Signal Processing

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Further data analysis details available.
Refer to the LLNL Micro-Power Impulse
Radar group for additional information.



Summary

Our research has shown that a low power, UWB radar-based hardware/software combination can be used to autonomously detect, characterize, and identify target trains and potentially other types of vehicles.

Questions?

