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Wooded Area Detection Analysis

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Overview

- Problem Description & Approach
- Data Collection and Description
  - Location and Setup
- Results
  - Sensor Probability of Detection in the Woods
  - Detection Map
- Future Areas of Work
  - Spatial Significance Data Fusion
    - Kuldorf's
  - Tracking Association and NAR Rejection

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Problem Description & Approach

Objective

- Assess Capability to Detect People in the Woods

Approach

- Collect Sensor Data in Woods
  - Decomposing Matter
- Collect Sensor Data in Woods with Clear Out
  - Decomposing Matter + Wood Chips
- Use SNL Sensor Systems
  - Assess Probability of Detection versus Range
    - Generate Sensor Probability Detection Curves
    - Generate Statistical Detection Map

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Wooded Area Data Collection Part 1
Recording Raw Seismic Signals

- Deployed 48 Seismic Recording Geophones
- Performed Walk + Run Tests

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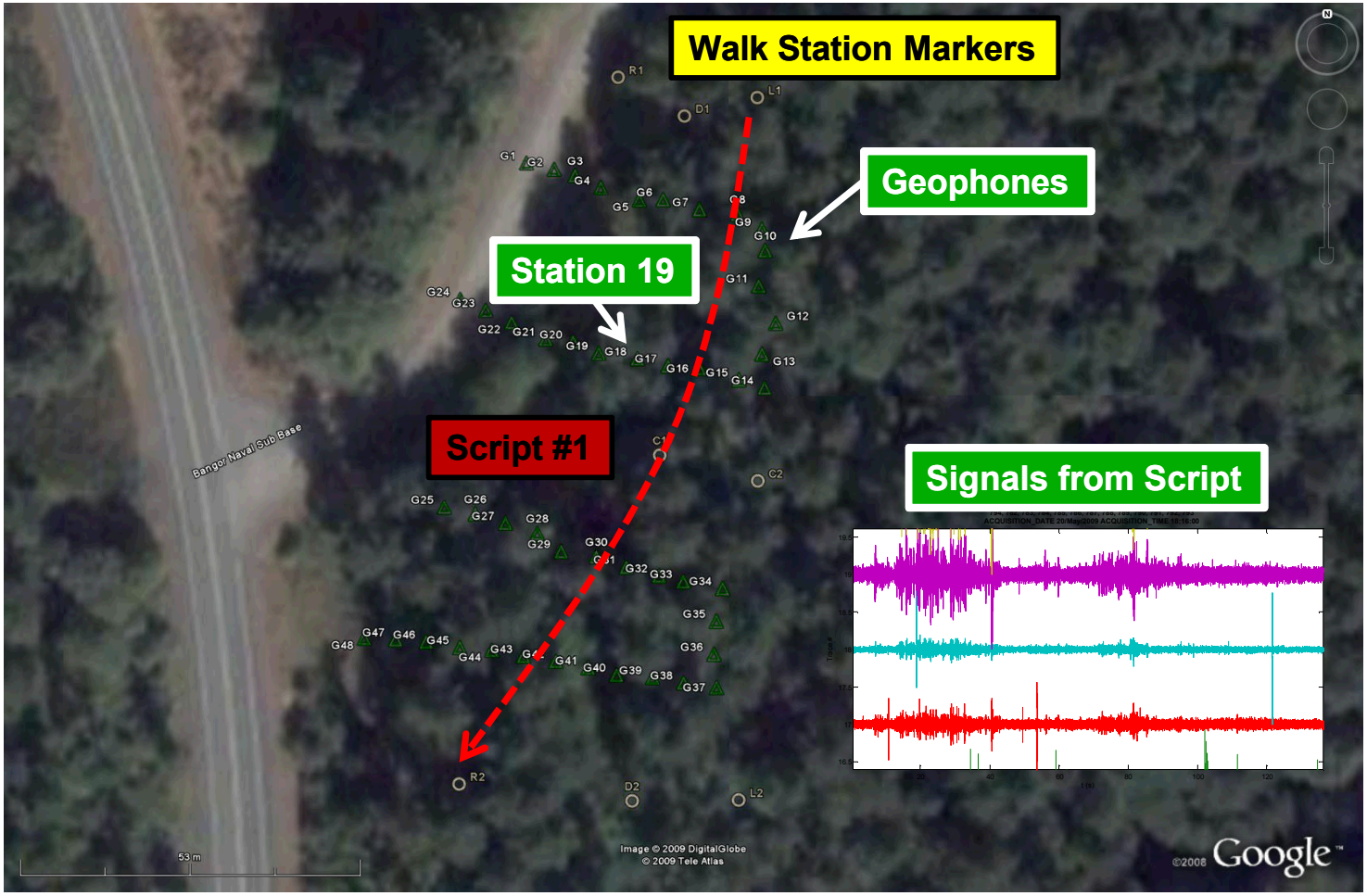
Walking Script Quick Look

- Analyze Data for Script and Look for Walking Signatures
- Use Station 19



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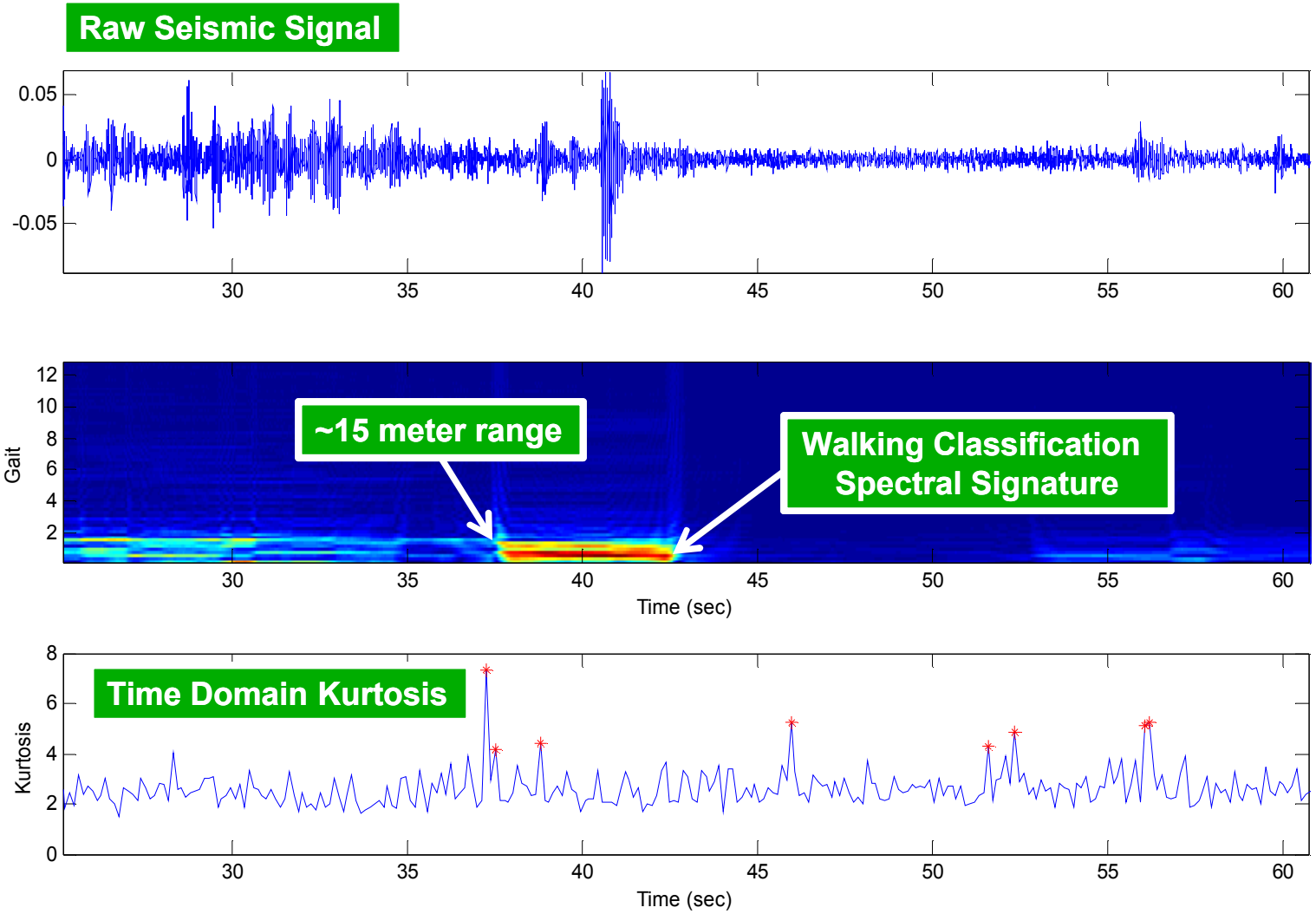
Algorithm Detection Station #19



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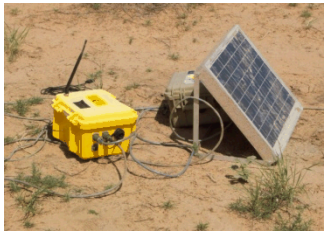
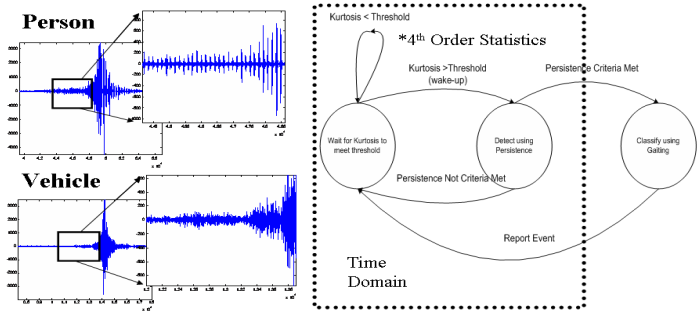
Wooded Area Data Collection Part 2
SNL Sensor Systems

- **Deployed 8 SNL Sensor Systems** (10 Hz Vert. Geophones)
- **Performed Walk + Run Tests**



SNL Sensor
3 Channels Per Sensor
(8 Sensors = 24 Channels)



Advanced Algorithms

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Single Sensors Range Assessment Walk Script

- **Walk Along the Sensors**
  - **Walker has GPS Ground Truth Shown in Purple Path Below**
- **Purpose**
  - **Assess Detection Range For Single Sensor System**
  - **Simulates Apriori Knowledge of Sensor System**

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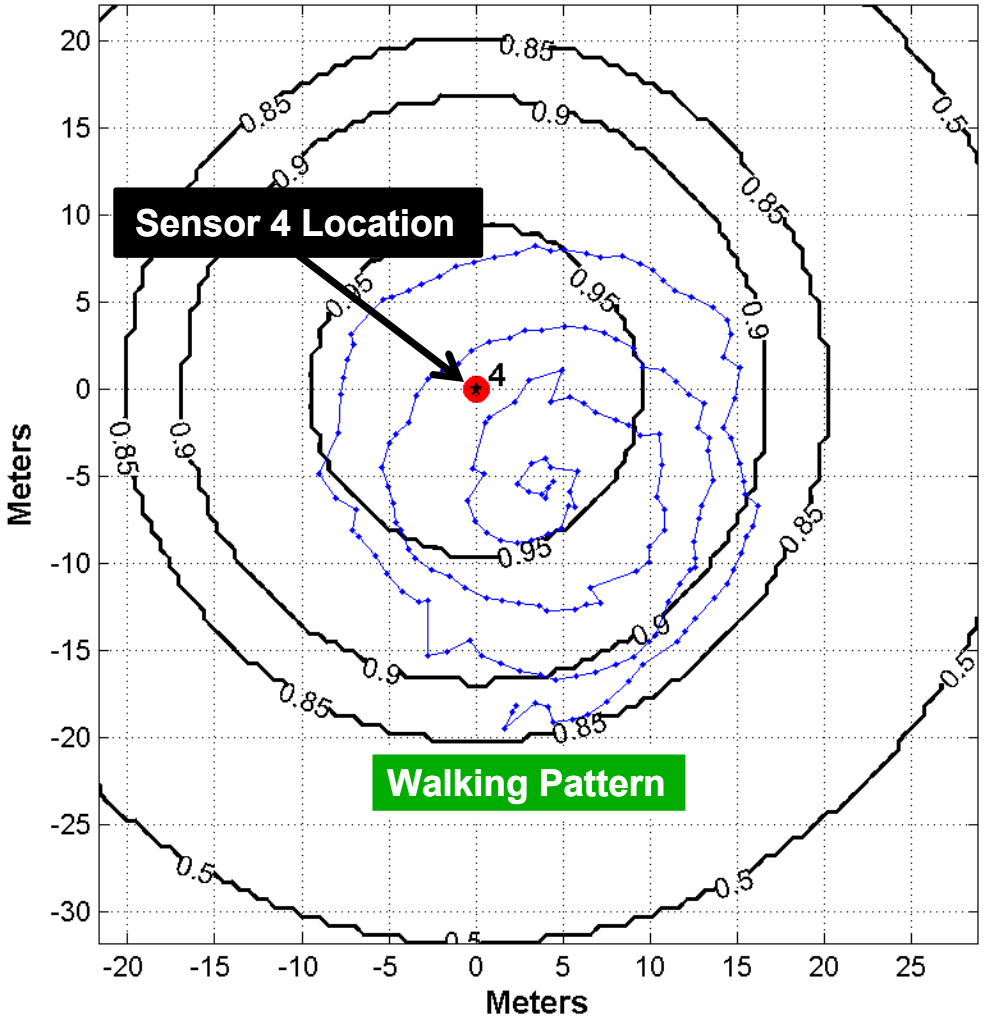
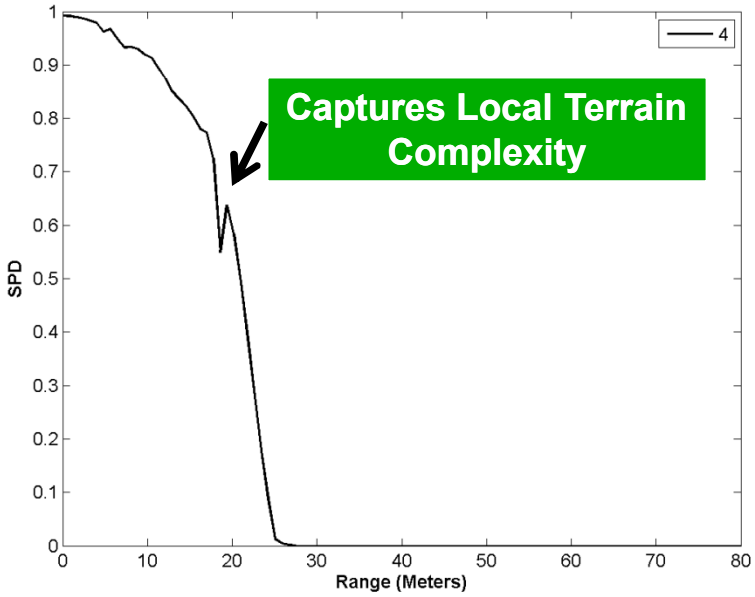
Sensor Probability Detection Fuction
Sensor 4: Wood Chips + Moss + Overburden



Single Sensor SPDF



Spiral walk used to assess detection probability Relative to range

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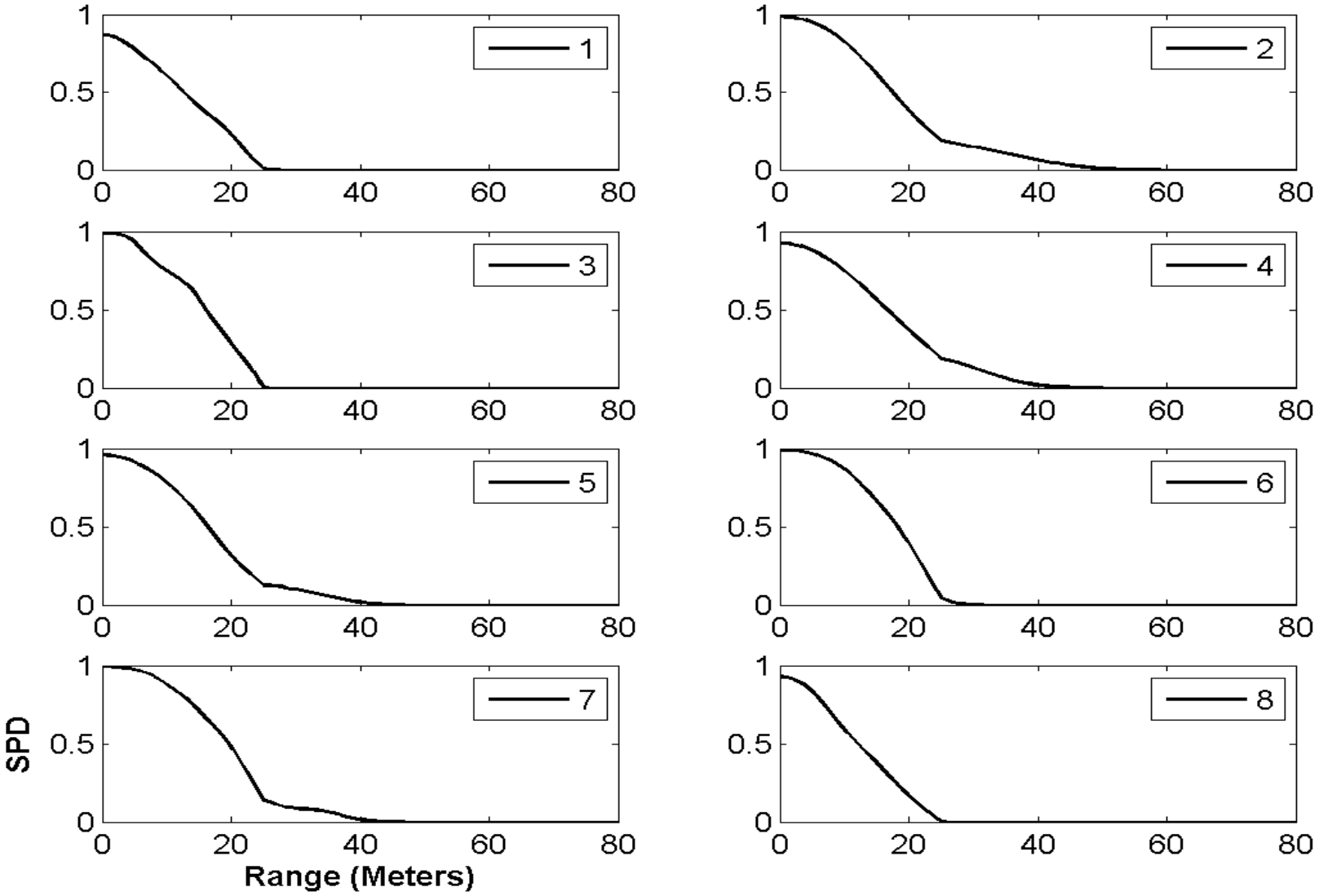
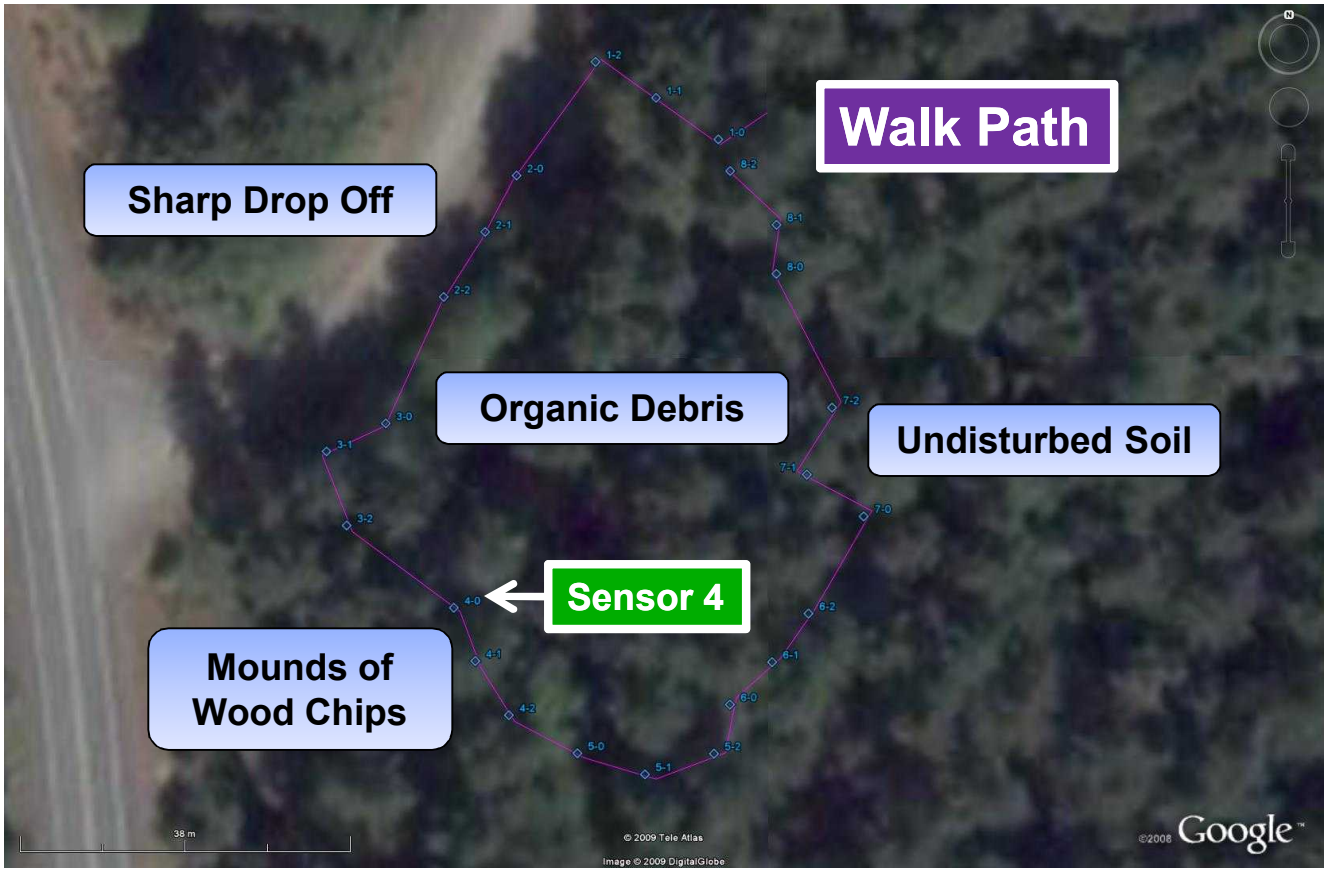
Sensor Probability Detection Function (SPDF) For Deployed Sensor Network

Differences in SPDF Reflects Local Terrain Complexities



All Sensors Range Assessment Walk Scripts

- **Walk Along the Sensors**
  - **Walker has GPS Ground Truth Shown in Purple Path Below**
- **Purpose**
  - **Assess Baseline Detection Range For Each Channel**



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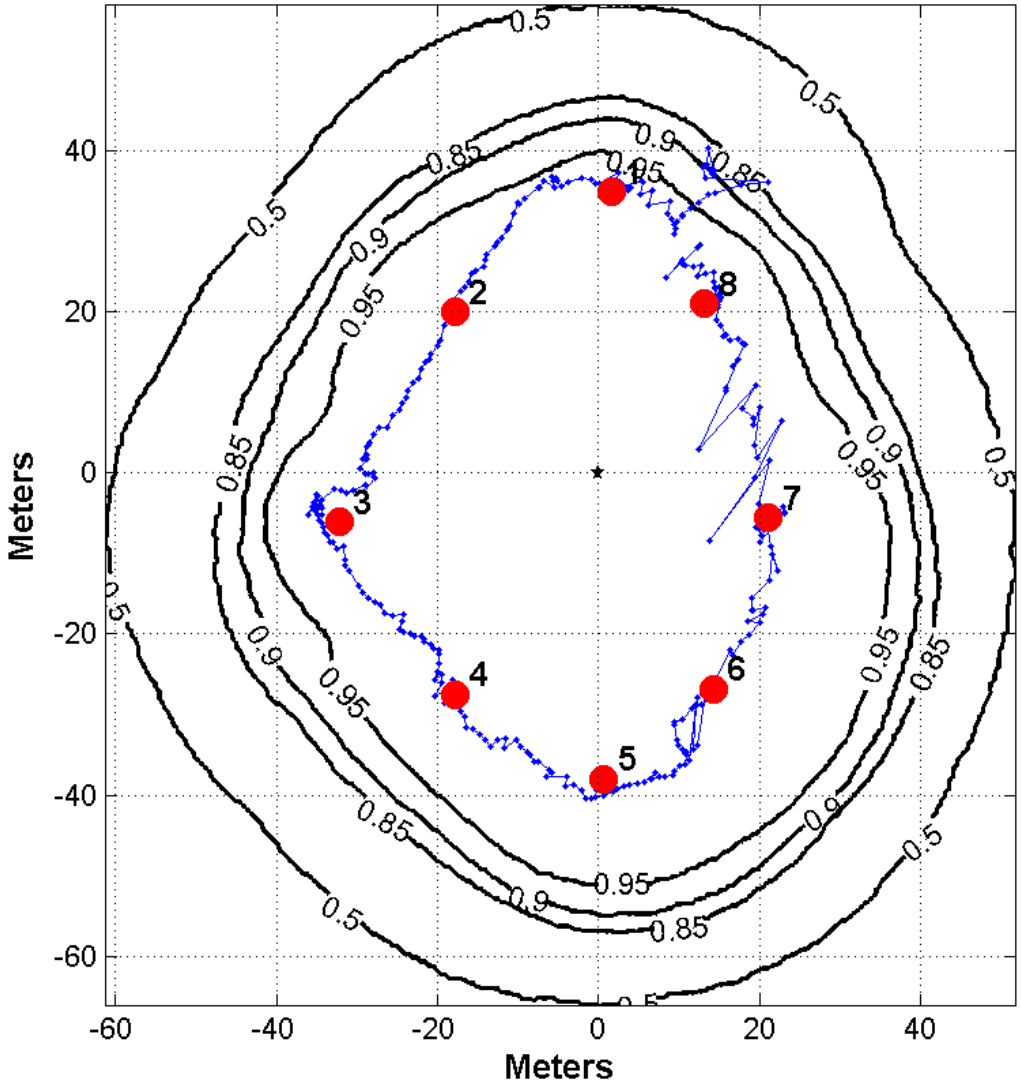
Fuzed Detection Map Results Entire Sensor Network



- **Fuzes all Sensor SPDF's**
- **Determins Pd as a function of the Entire Sensor Network working Together**

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Approach to Generating Sensor Probability of Detection Curves

Sensor GPS

Walker GPS

GPS, Time

Estimate Range To Target

Range

Sensor Detections With Time Stamps

Detections

Time

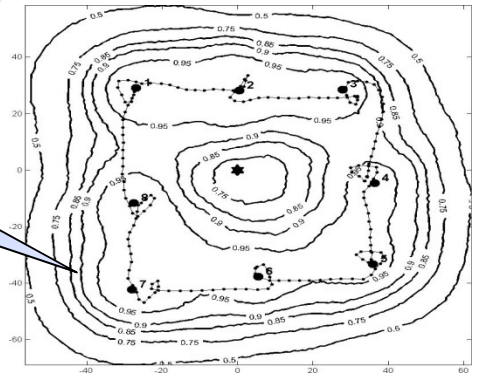
Sensor Probability Detection Function (SPDF) Calculation

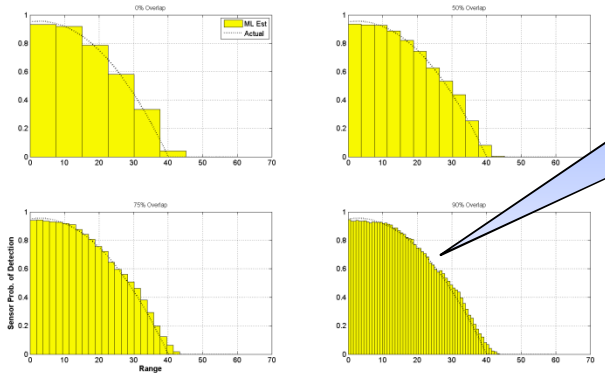
(Pd, Range)

Pd vs. Range Curves

Data Fusion All Sensors into Detection Map

(Pd vs Location) Entire Sensor Network





(Pd vs Range) Individual Sensor

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Testing the Distance of a Single Sensor

- Walked a single sensor as deep into the dense woods as possible
- Marked off ~5 meters spacing up to 35 meters and walked in place
- Assessed at what distance did the signal degrade
  - Provides Upper Limit On Ideal Detection Case

Distance (m)	Detected (Y/N)
15	Y
20	Y
23	Y
25	Y
30	Y
35	N

- These results are highly variable with terrain and are probably not typical in all cases
- In place walking is similar to walking around in a circle with a constant radius from the sensor
- Results do indicate that robust detection with a low NAR is possible

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Conclusions

- Test detected walkers in the woods
- Single sensors do offer limited operational effectiveness
  - High Probability of Detection at a relatively close range (~10-15m)
  - Probability of Detection varies greatly within a small area
- Sensor systems working together greatly improves effectiveness
  - Fuzed results work together to perform accurate detection
  - Detection zone becomes much more significant (in terms of size/distance)
- Data shows that tracking a target is promising in these conditions even with the limited range compared to desert soil conditions

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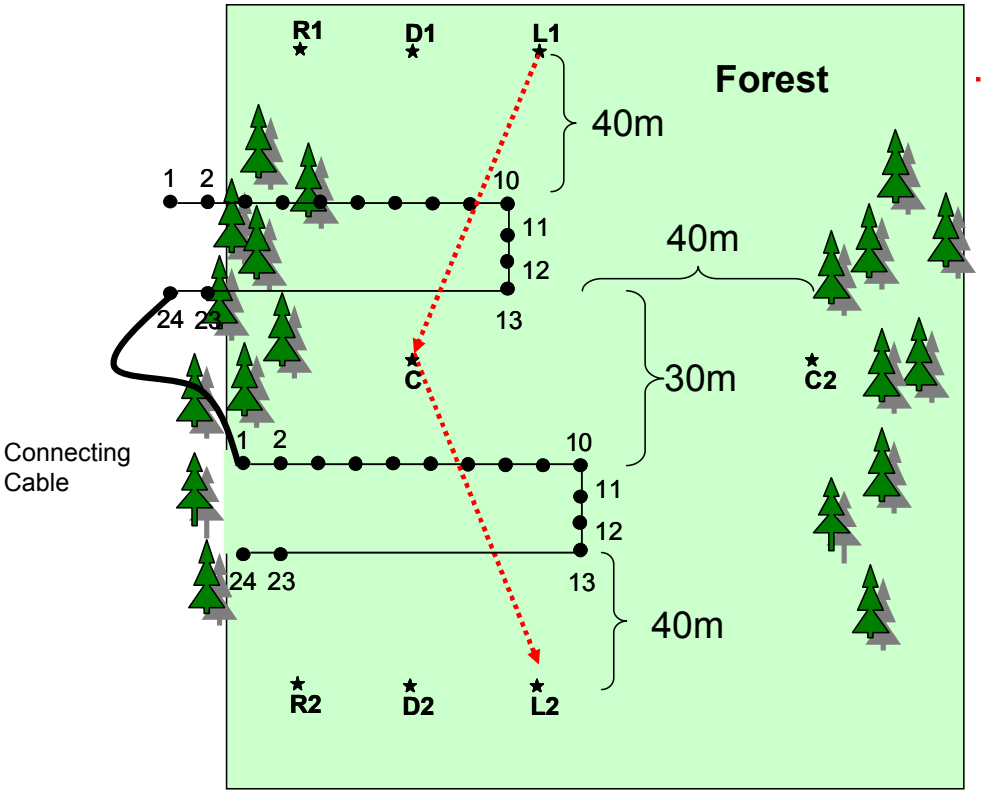
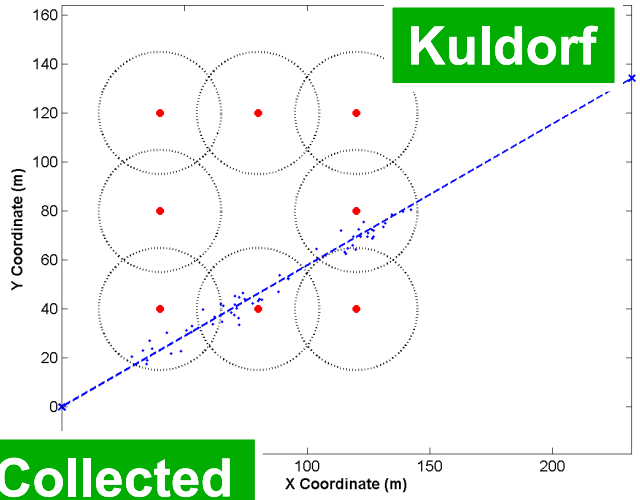
Future Work
Areas of Internal SNL Research

- **Tracking and Data Fusion for**
  - **NAR Rejection**
  - **Inference of Threat/Risk**
- **Using Motion/Space/Time**

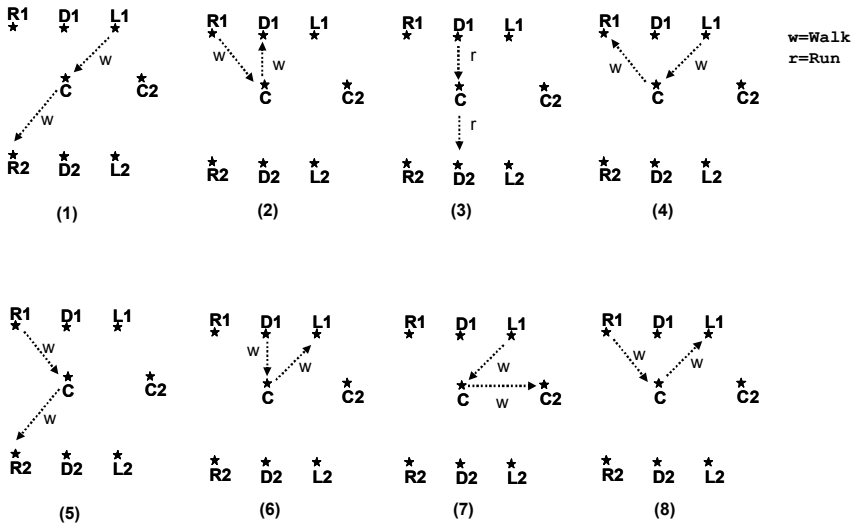


Layout Collected Against

= Example pattern



Scripts Collected



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