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Development and Deployment of a Ground Robotic Platform for Radiological Contamination Detection

Bryan Steinfeld, Los Alamos National Laboratory

April 16, 2024

Project Sponsored by
DOE – Environmental Management Technology Development Office
EM-TDO

Primary Goals

- Deliver verifiable **MARSSIM** data and maps to meet client requirements using available OTS technologies

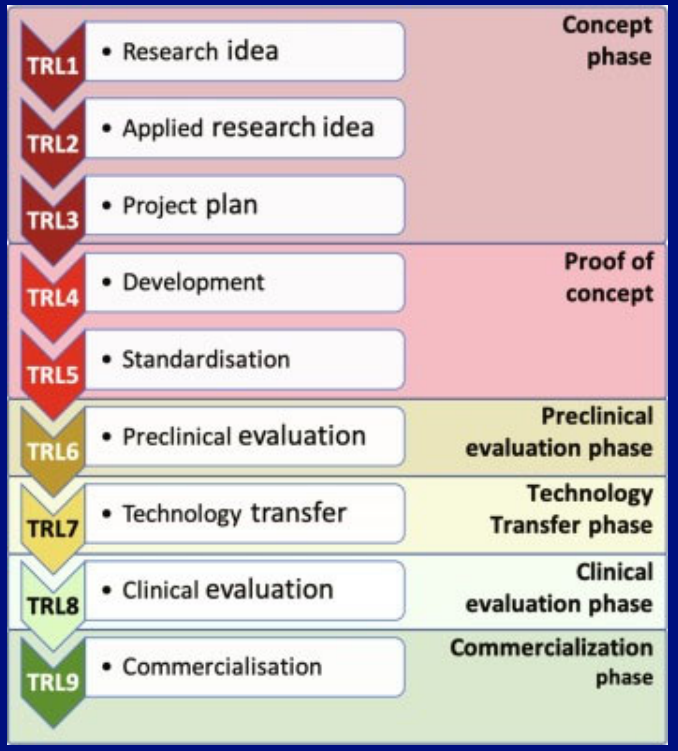
- NuHorizon Technologies provides custom integration of proven technologies

Project Overview

- iGART System Developed by Nu Horizon Technologies
  - DHS funded the original platform through SBIR
  - Modifications performed as part of current project to target EM-LA application
- LANL/EM-LA identified as candidate site given existing site operation
  - Phase 2 Work Plan for Potrillo and Fence Canyons Aggregate Area
- Demonstration of system performance at existing EM remediation site
  - Perfomed September 25-29, 2023

Problem Statement

- Challenges inherent with moving technology through TRL 5-7
  - Stakeholders
    - Central Technology Development Office
    - EM Site Management
    - Contractors/Subcontractors responsible for execution of work
  - Access restrictions for operational areas
    - Safety/Security
    - Work/Project Schedules

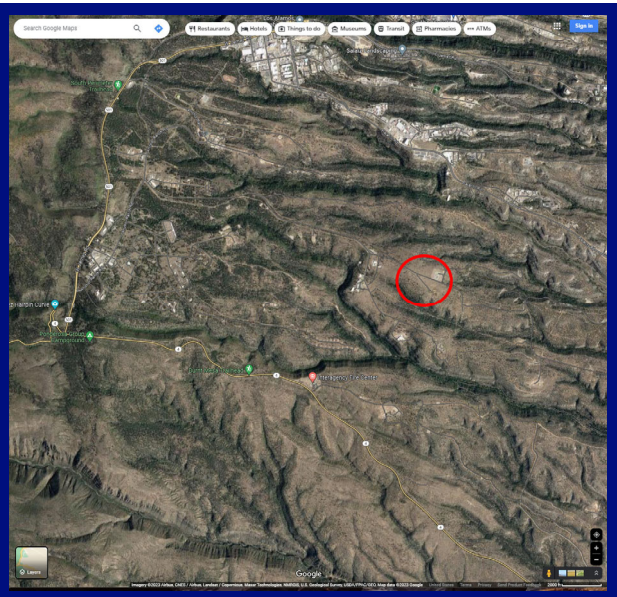


MARSSIM Mapping

- Multi-Agency Radiation Survey and Site Investigation Manual
- Framework defining overall guidance for characterizing surface contamination
  - Does not address sub-surface contamination
- Primary use: final status survey for site release
- Will help site operators get to the final goal of releasing sites
- **Flexible procedure** regarding the number and location of measurements/samples over defined area
  - Dependent upon Data Quality Optimization (DQO) process to establish viability of contamination mapping

Site Background

- Part of Potrillo and Fence Canyons Aggregate Area Phase II Cleanup plan for EM-LA/N3B
  - Multi-year cleanup plan executed by N3B
  - Surface Firing Site 1946 – 1981
  - Natural Uranium, DU, Beryllium, and other metals as hazards



Project Approach

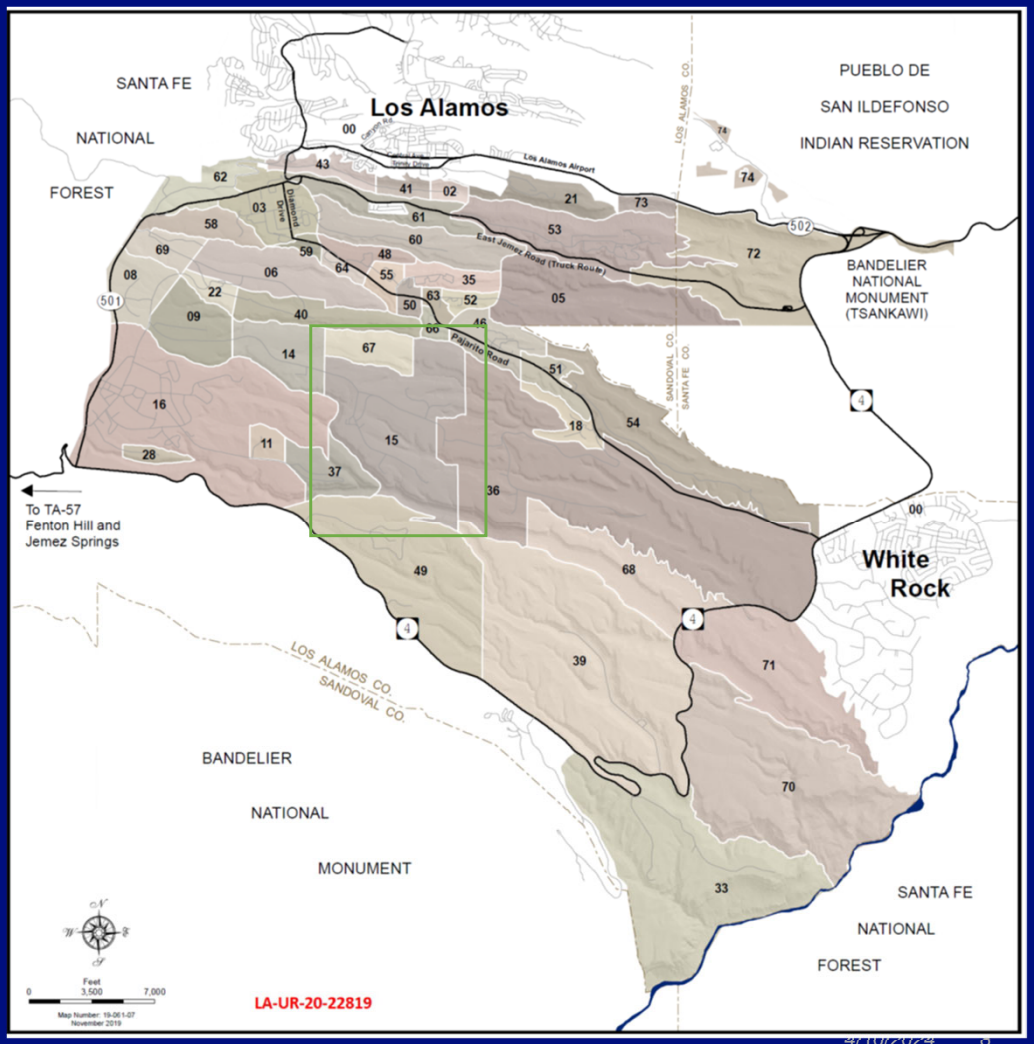
- Adapting robotic detection platform originally developed by Nu Horizon Technologies with DHS (iGART[1])
  - Previously demonstrated at SRNL
  - Capable of performing gross radiation activity measurements in addition to isotopic discrimination
- Partnered with EM-LA field office and N3B[2] to define specifications and requirements and candidate site for deployment
  - E-F Firing site located at TA-15 in LANL
  - Part of active Potrillo and Fence Canyon Aggregate Areas Phase 2 work plan

iGART system located at LANL E-F Firing Site

1. Integrated Ground-Based Agent for Radiological Tracking
2. Newport News Nuclear BWXT

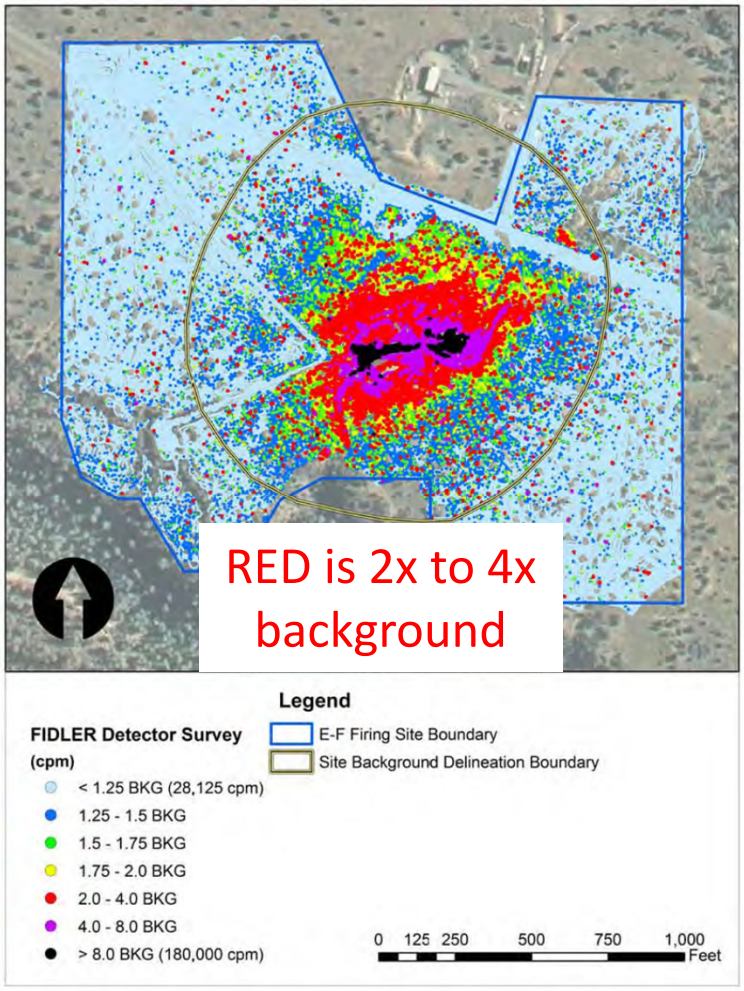
Site Background

- Part of Potrillo and Fence Canyons Aggregate Area Phase II Cleanup plan for EM-LA/N3B
  - Multi-year cleanup plan executed by N3B
  - 42 Solid Waste Management Units (SWMU)
  - 27 SWMUs identified for cleanup based on 2010 investigation
- Tech Area-15 (R-Site) used from the mid-1940s for explosives experiments
  - Natural Uranium, DU, Beryllium, and other metals as hazards
  - Approximately 1200 acres in total

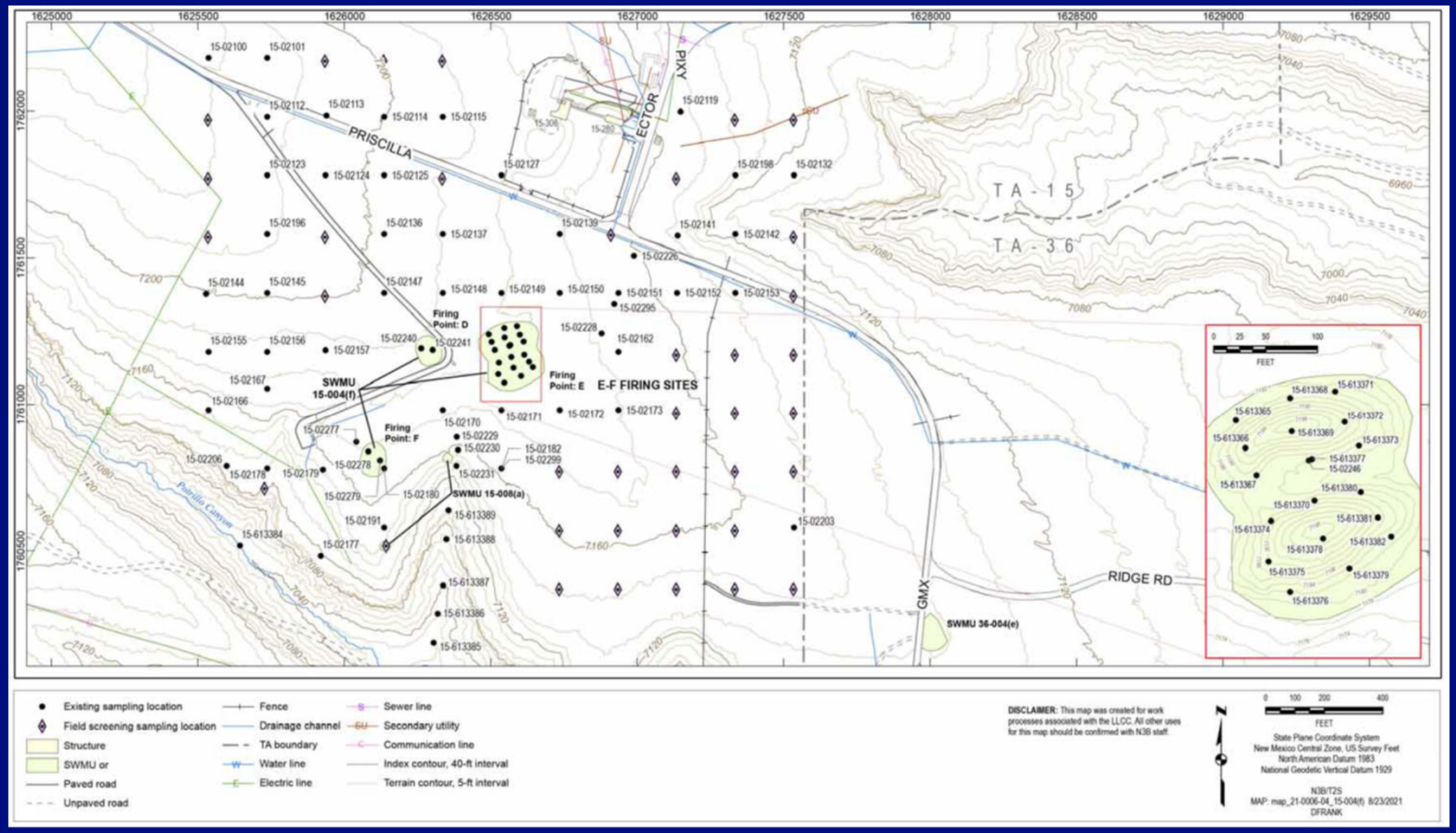


Prior Survey Data

- Collected in 2010 via FIDLER walkover
  - Entire site surveyed relative to background radiation
  - Large amounts of DU and isotopic uranium
- Surveys conducted in March
  - Not shown here, in broad agreement with this data



E-F Firing Site Historical Survey Grid

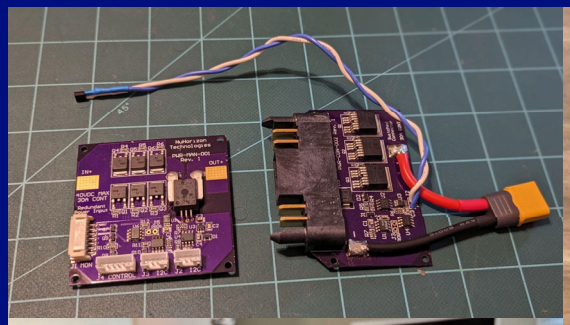


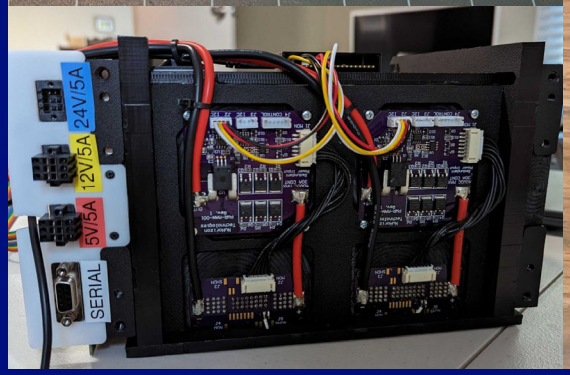
Igart Robotic Mapping Platform

- Integrated Ground based Agent for Radiological Tracking
- 94 cm tall
- Max speed 0.75 m/s
- >5km range
- Software run in Docker containers

Custom Hardware

- Specialized microcontrollers for sensor integration
- Custom Li-ion battery ecosystem
- Rugged base station





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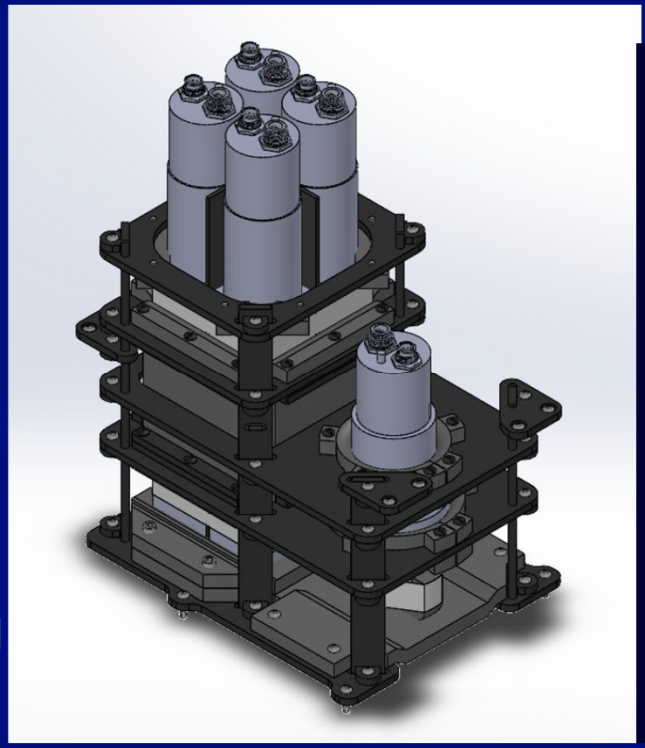
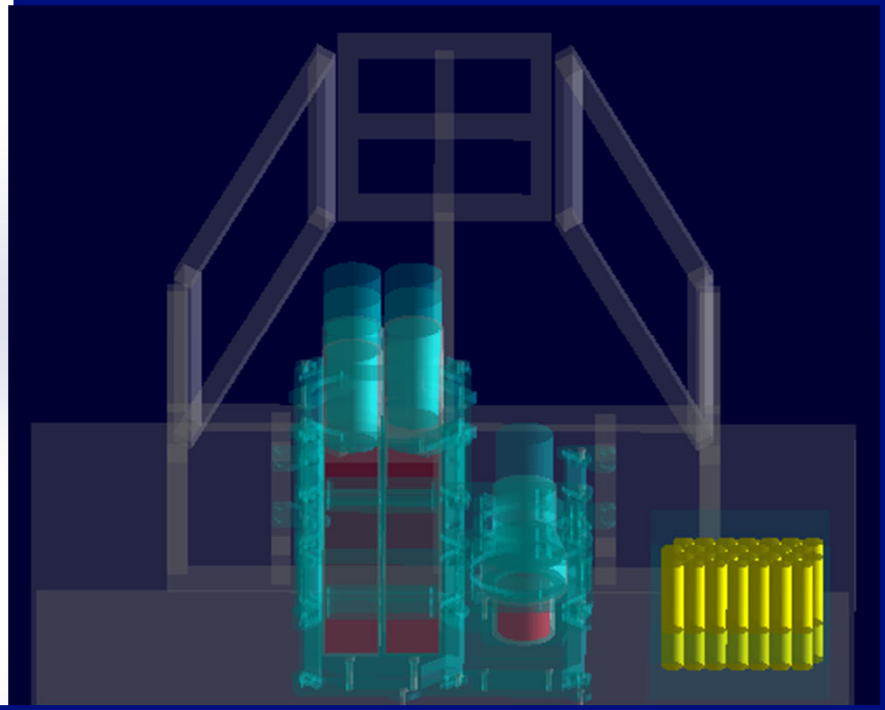
Integrated Gamma Detectors

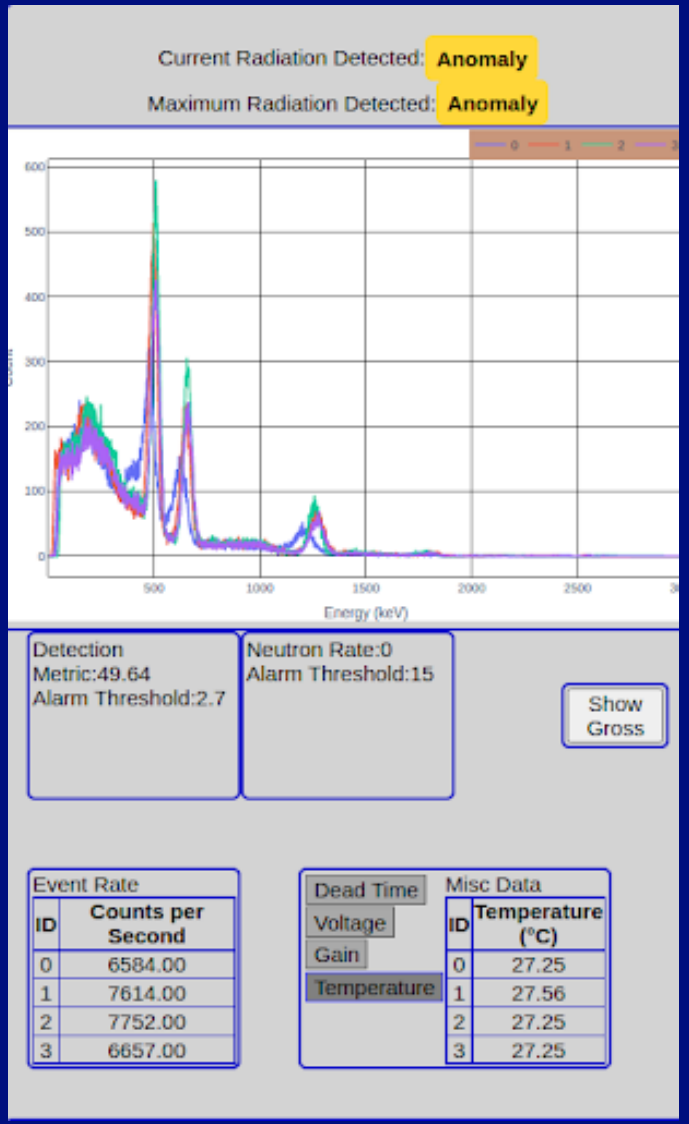
- Four NaI(Tl): anomaly detection directionality
- SrI2(Eu): identification
- Downward facing for ground mapping



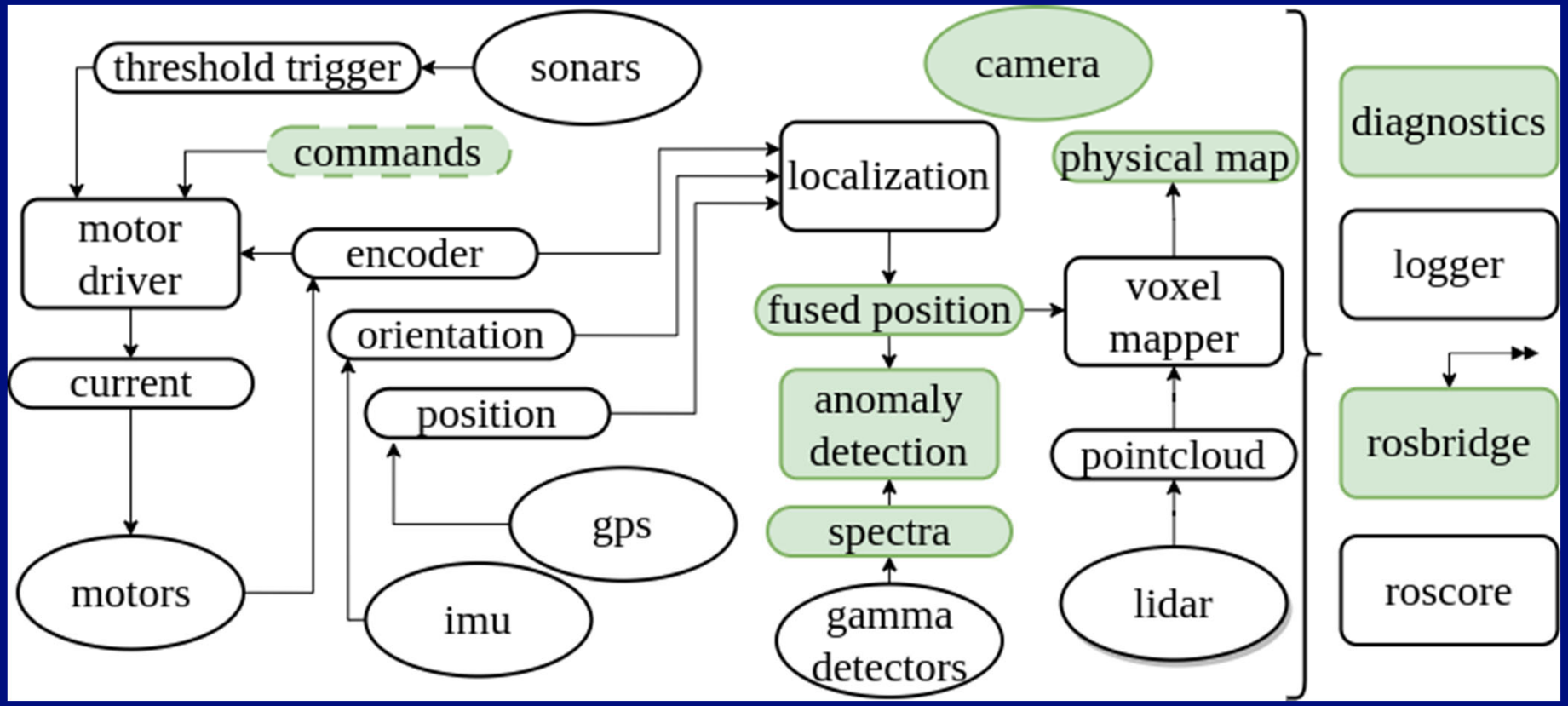


Detailed Radiation Detection

- Alarm metric (same as non-detailed)
- Full energy spectra
- Current gamma metric and alarm threshold
- Current neutron count rate and alarm threshold
- Toggle to display net or gross spectra in section B
  - Use net spectra for visual identification
- Latest gamma detector count rate
- Additional gamma detector metrics

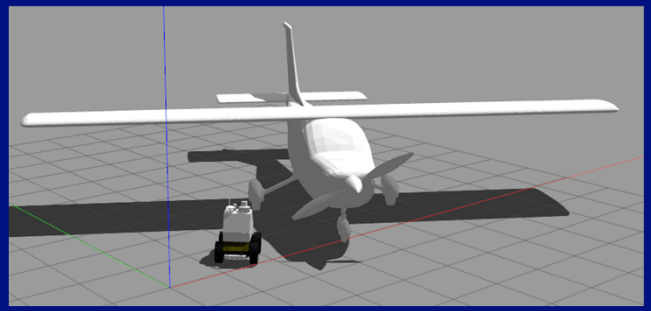


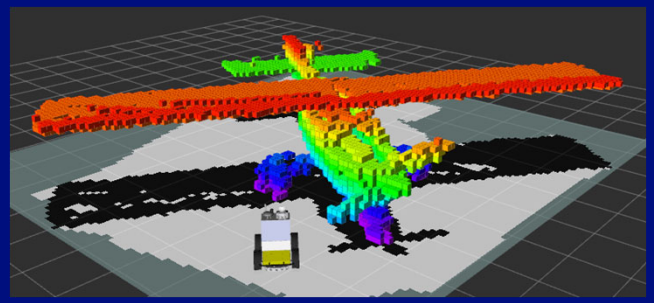
On-board Software w/ Robotic Operating System (ROS2)

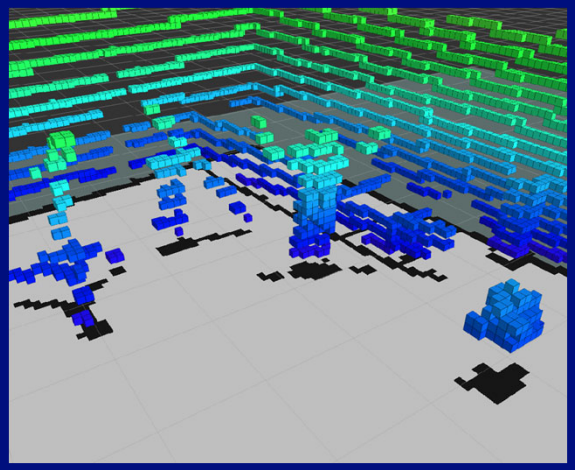


Environmental Awareness

- Simultaneous localization and mapping (SLAM)
  - Fuse sensors for real-time pose
  - Combine with lidar for obstacle map

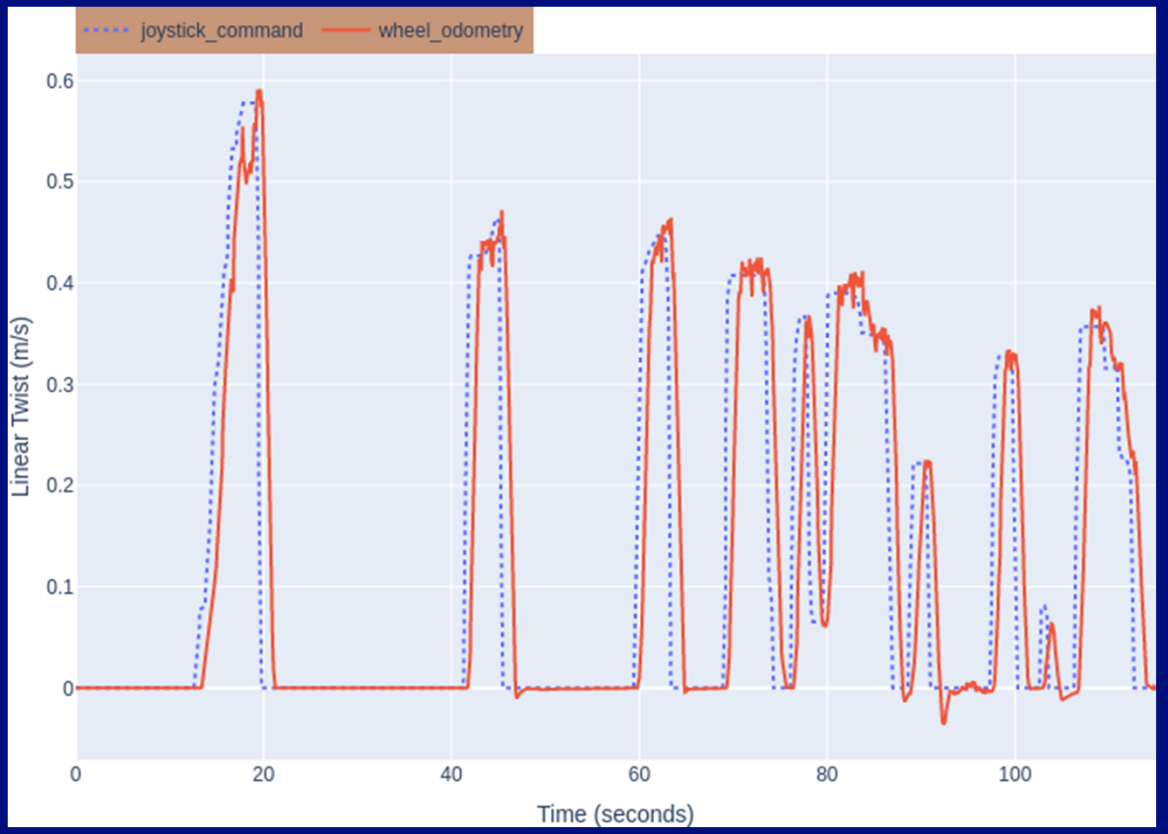






Comprehensive Data Acquisition

- System logs robotic and radiological telemetry
  - Real-time analysis for fault monitoring
  - Post-processing for survey understanding



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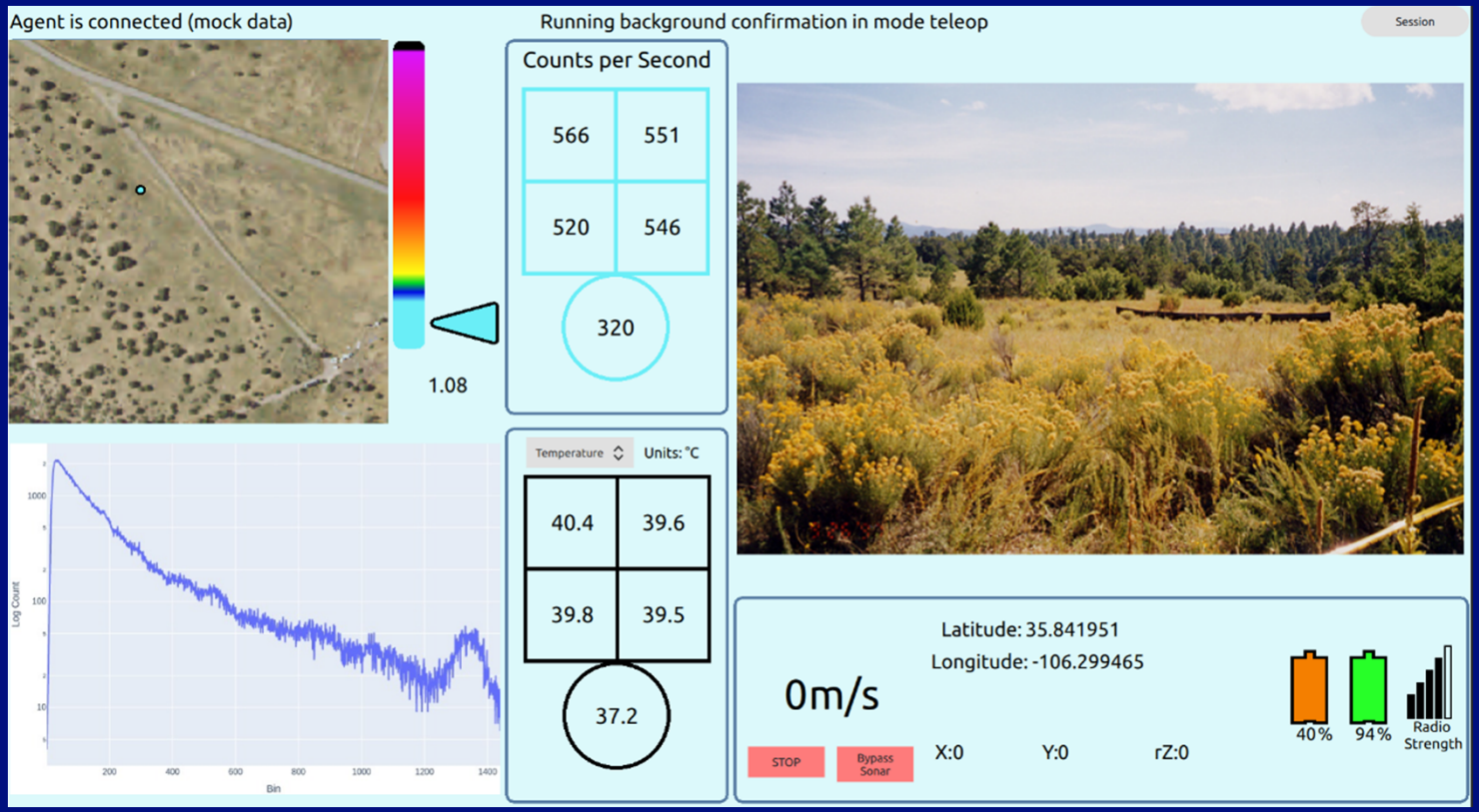
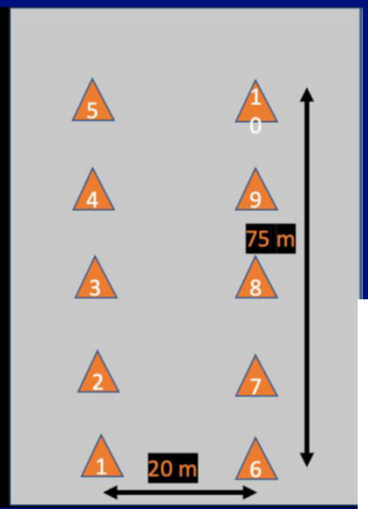
Custom Interface for Remote User

- Live video stream
- Robotic telemetry
- Radiation metrics
- Heatmap
- Adjustable settings

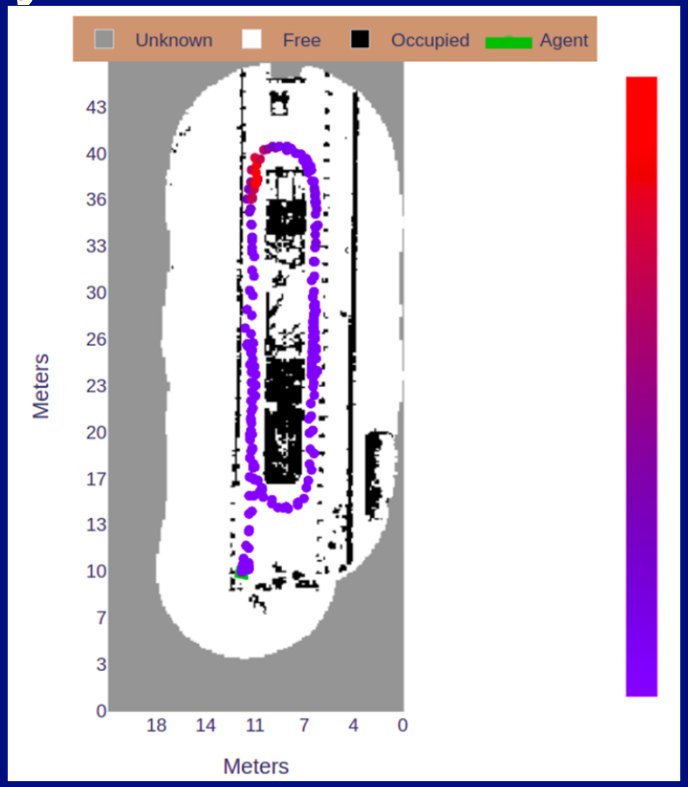


Demonstration Images (Pavement)

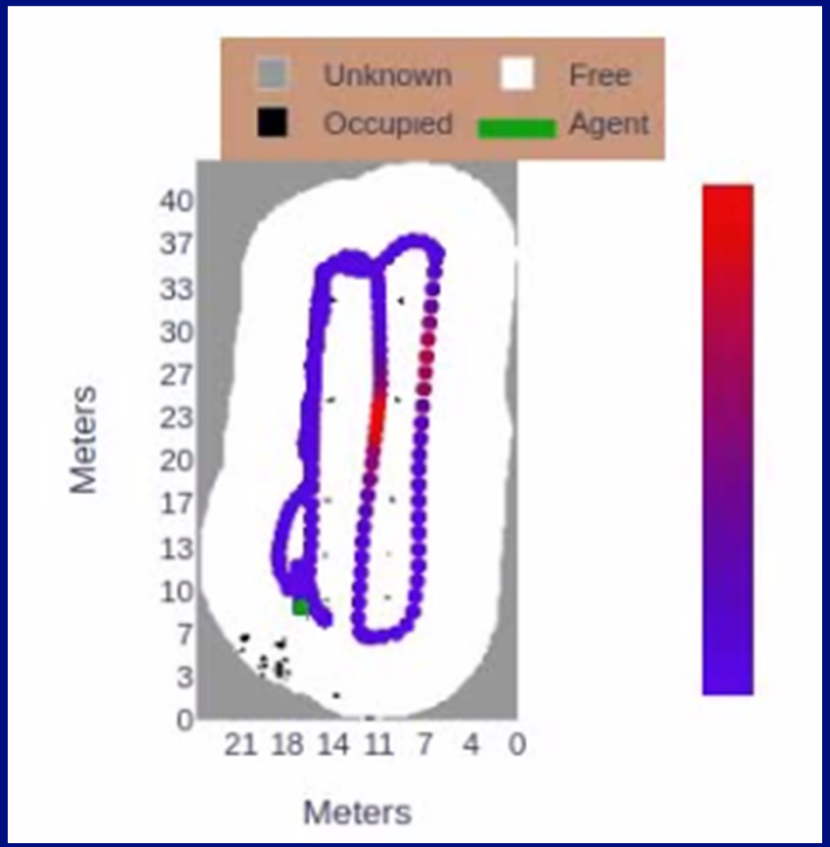


Demonstration Images (Terrain)

Early Results



Source inside tractor-trailer



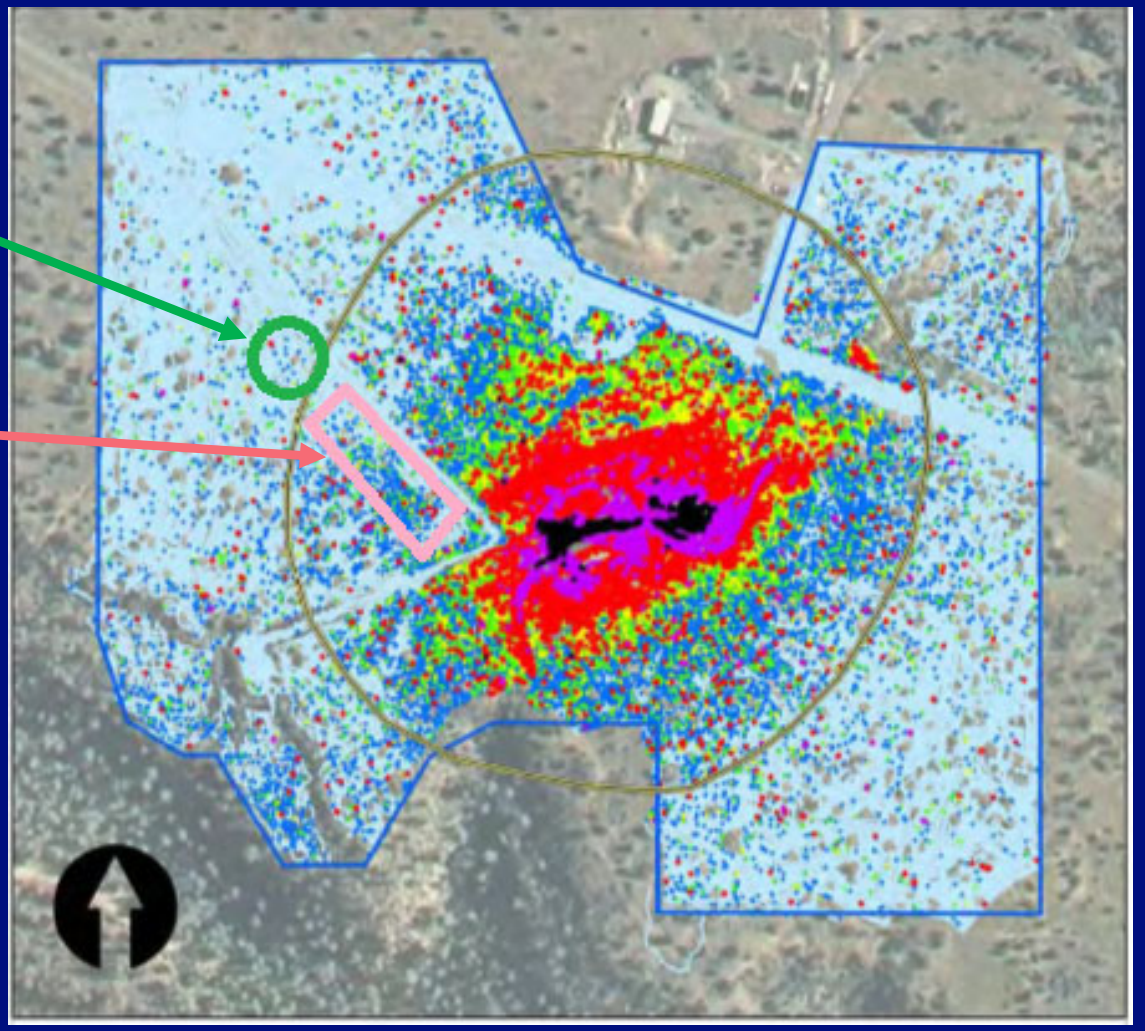
Source underneath traffic cone

Approximate Sampling Locations at E-F site (Sept. 2023)

Initial survey area in green

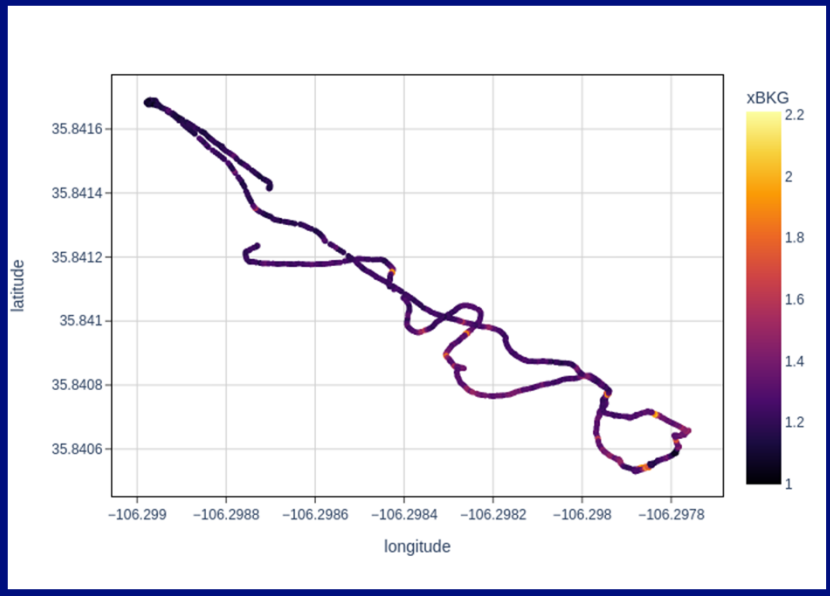
Follow-on survey area

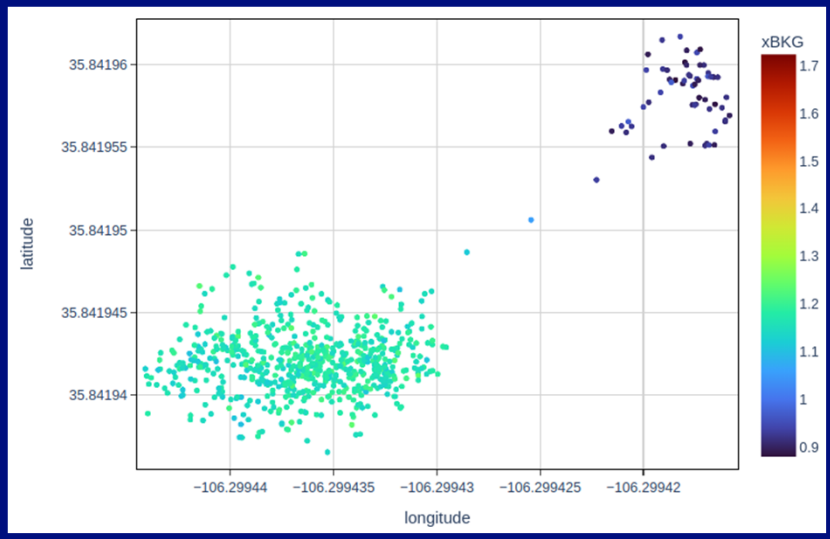
RED is 2x to 4x background



Contamination Survey Data

- Top: low resolution heat map of hot spot identification of during survey
  - Image shows multiple data points approximated over path to ID hot spots in robot path
  - xBKG represents measured rad activity relative to background as a percentage
  - Detector path ID'd areas up to ~2x background
- Bottom: high resolution data for robot measurements in localized area
  - Graph shows transition from uncontaminated area to higher background readings in contamination





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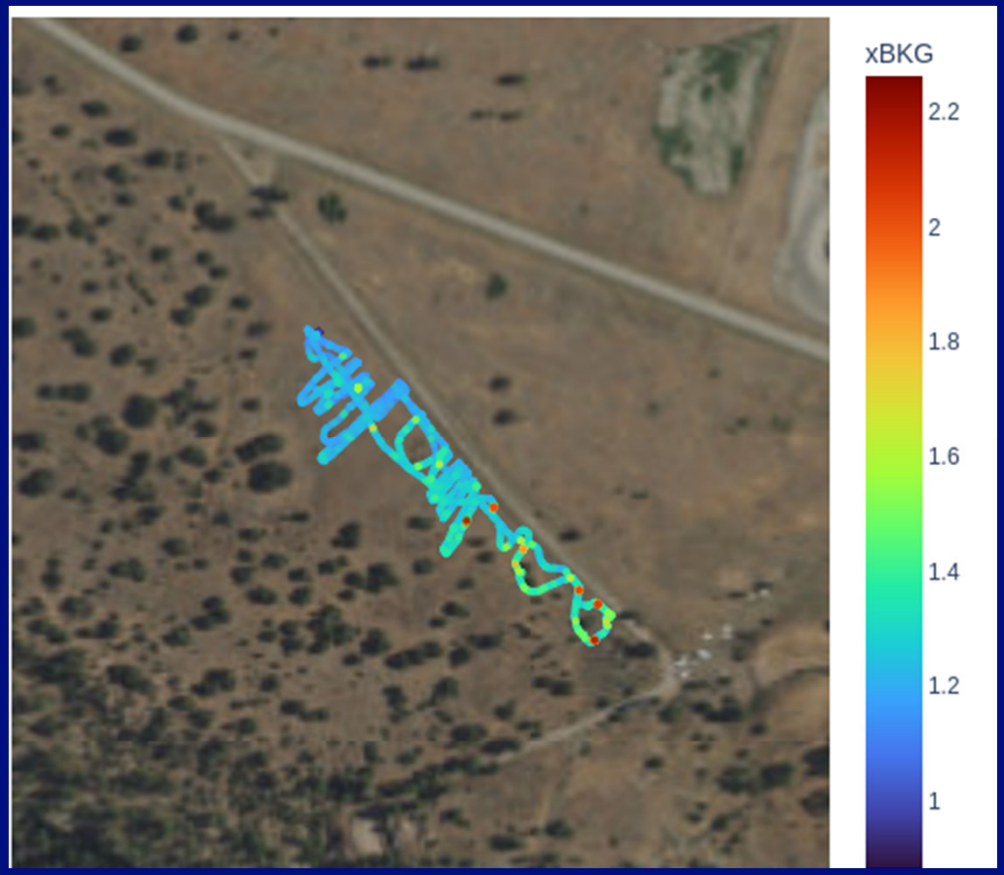
Survey Heat Map w/ Terrain



Photos from Deployment

Upcoming Work

- Further refinement of system design
  - Incorporation of additional autonomy/automation
    - MARSSIM Map Generation
  - Alternate material sensors
    - XRF
    - Heavy metals relevant to site remediation
  - Improved robotic system mobility options
- Additional simultaneous deployment with upcoming walkover survey
  - Like-for-like data comparison