



ADVANCED REACTOR SAFEGUARDS

Security Systems of the Future for SMRs and Microreactors – FY23 Activities Update

*A New Architecture for Perimeter Intrusion Detection System (PIDS)
Deliberate Motion Analytics-enabled PIDS: DPIDS*

PRESENTED BY

John “JR” Russell
Nuclear Security Engineering Group
Email: jlrusse@sandia.gov
Cell: 505 977-6707

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Discussion Topics

- What is DMA?
- What is DPIDS?
- Previous DPIDS work completed in FY22
- FY23 Testbed: work completed in FY23
- Planned DPIDS work for FY24



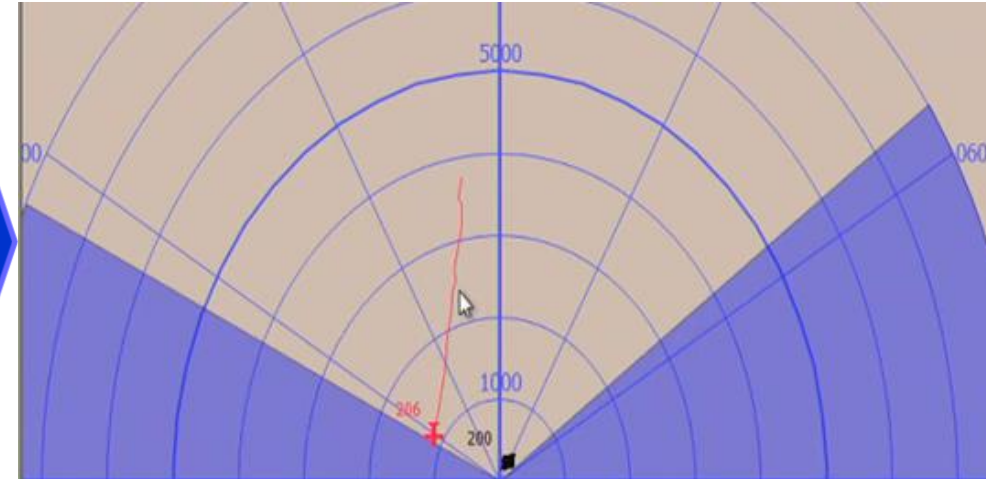


What is DMA? Deliberate Motion Analytics

- A sensor algorithm that can fuse multiple sensors to create a multi-physics hybrid-sensor system
- Enables explicit implementation of the principle of complementary sensors
- Uses deliberate motion to differentiate intruder alarms from nuisance alarm sources (including weather, moving fences, and foliage)



Actual screen shot: high NAR during light rain



What you want to see

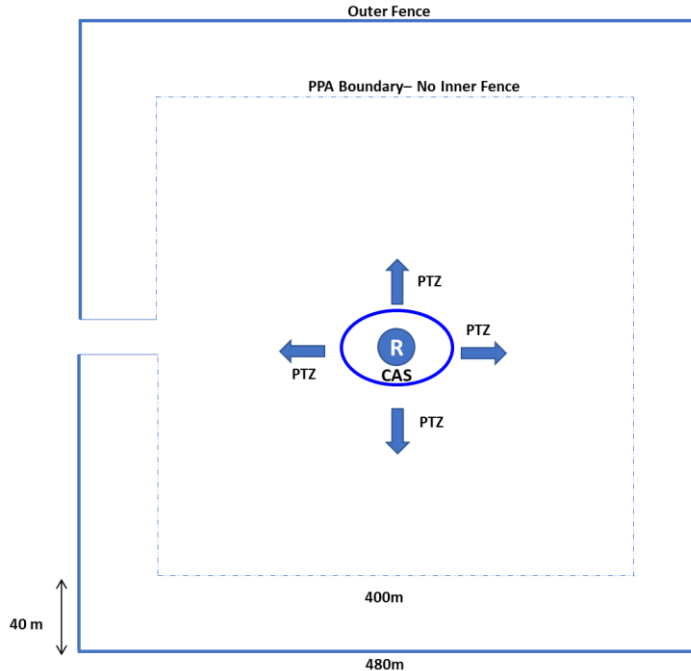
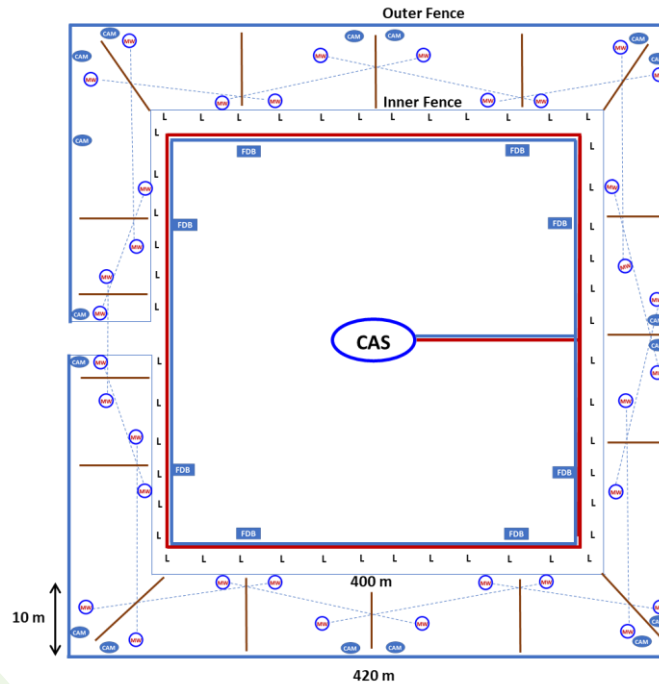
DMA: An enabling technology for new security architectures



What Is DPIDS? DMA-enabled PIDS

Traditional

- PPA boundary 400 m sides
- 17 sectors
- 34 microwaves
- 17 cameras
- 8 FDBs (field distribution boxes)
- 48 lights/light poles
- Trenching for power or comms
- 9-meter clear zone



DPIDS

- PPA boundary 400 m sides
- No sectors
- No FDBs
- No lights/light poles
- No trenching for power or comms
- 40-meter clear zone

Caveat regarding “no lights”

- No lights on perimeter needed for intrusion detection
- Lights on/around the CAS
- Safety and Response Force may require lights

DPIDS design is estimated to cost 40% less than traditional design

Used RSMeans Construction Cost Manual and from Advertised Material/Construction Costs

More detail breakdown in report “DMA enabled PIDS (DPIDS) A New Architecture for Intrusion Detection Based on Deliberate Motion Analytics”, SAND2022-12659 R

Previous DPIDs Work Completed in FY22

One Detection Zone

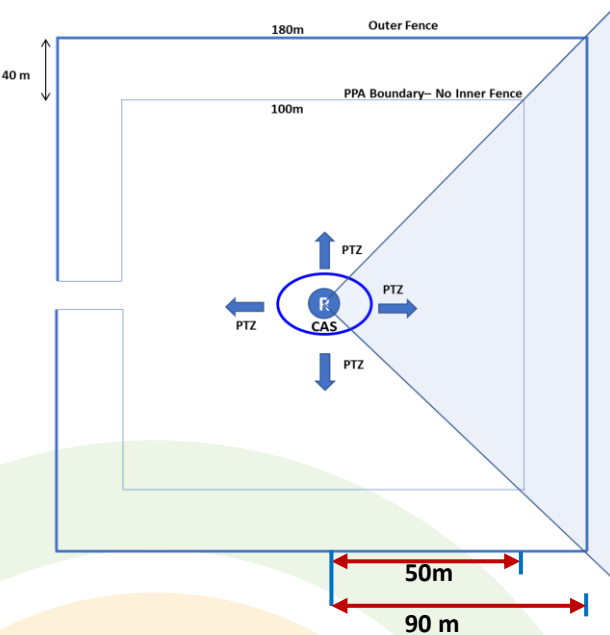


Detection Test Results (no misses)

Threat	Total Attempts	Total Hits	Total Misses	Ps at 95% CL
Walker Est. 1-3 feet/second	35	35	0	92
Runner Est. 10 feet/second	35	35	0	92
Aluminum Ball Drag Est 1-2 feet/second	35	35	0	92
Hands and Knees Crawler	0	0	0	n/a

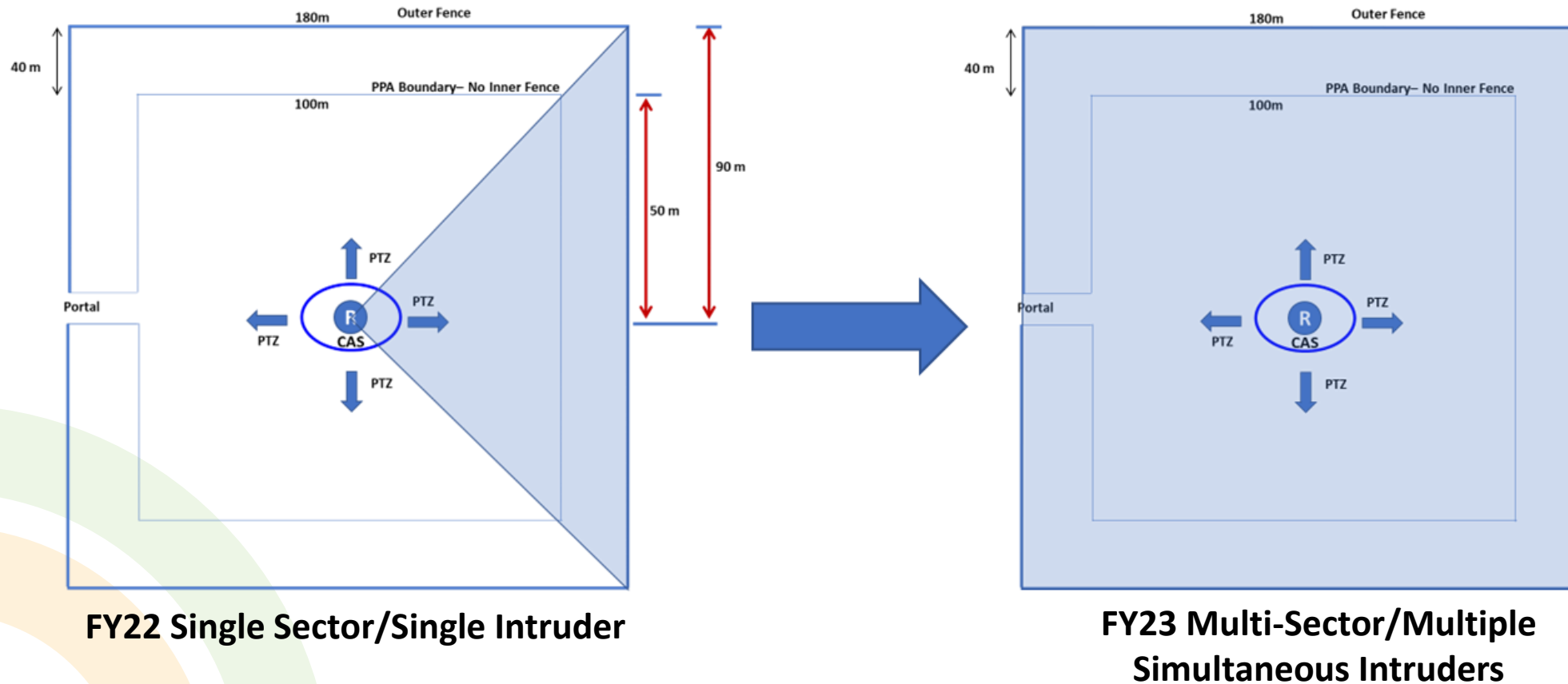
Nuisance Alarm Collection Results

Collection Period (days)	NAR Inside Detection Zone	NAR From Wildlife	NAR From Weather/Foliage	Average NAR Per Day
23.9	20	20	0	0.8

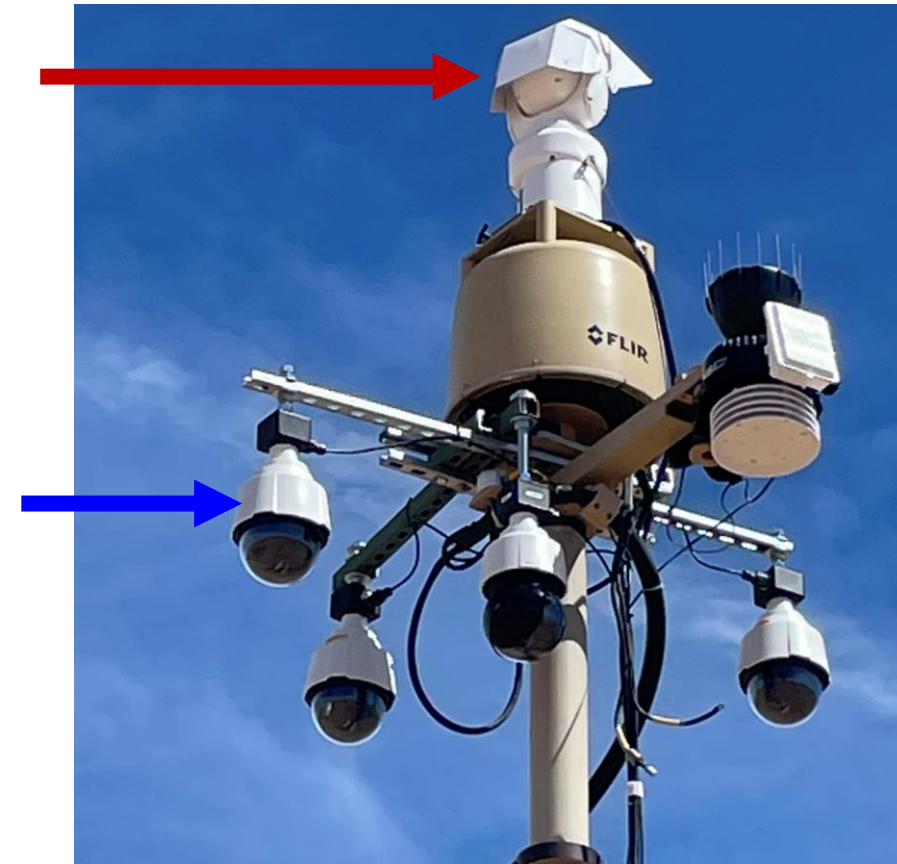
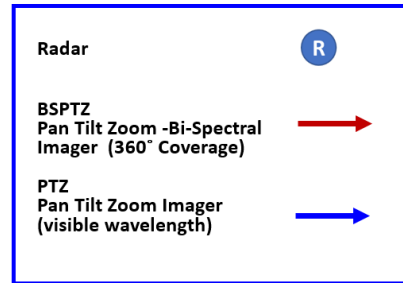
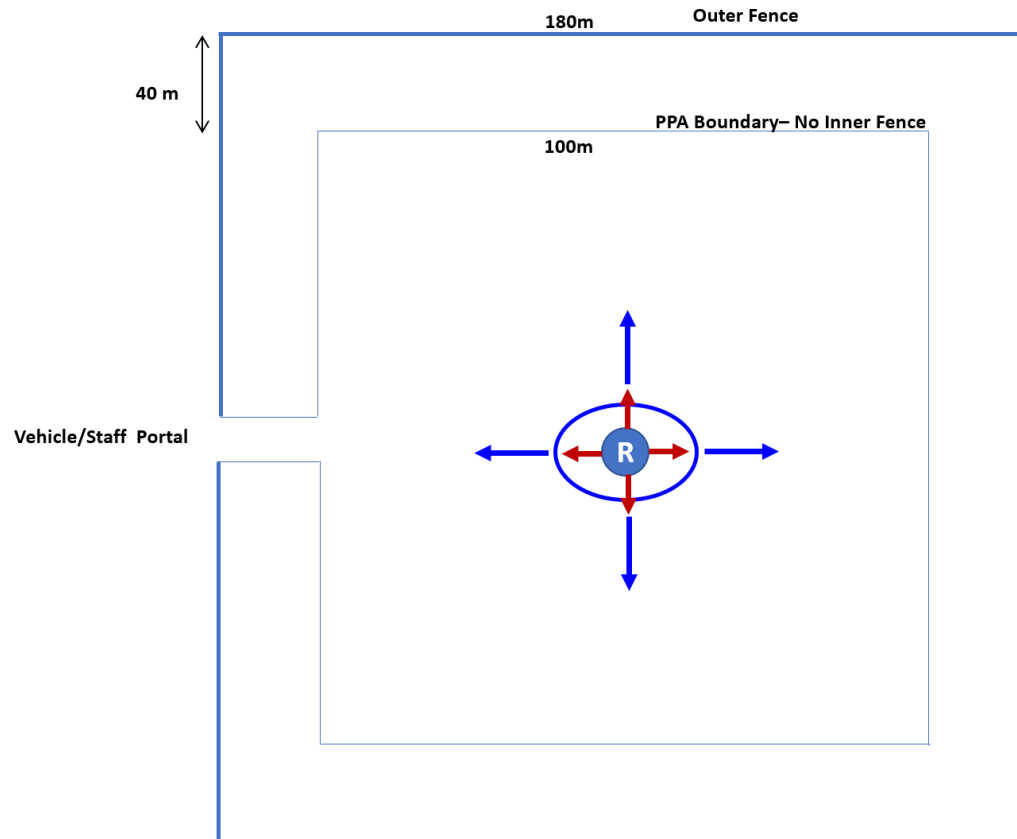


FY23 Testbed – Multiple Detection Zones

360-Degree Coverage

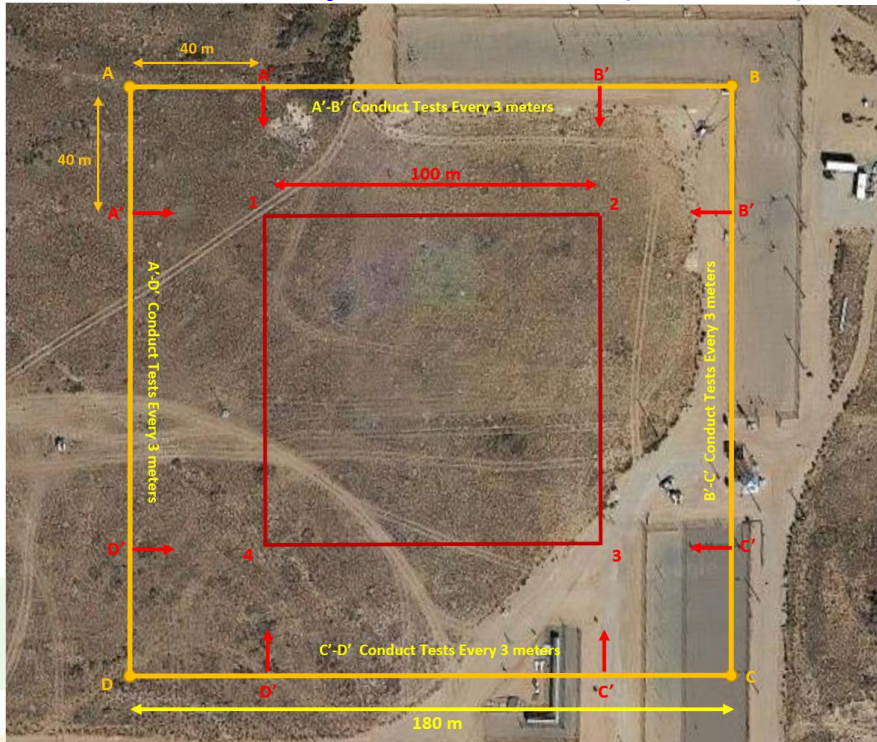


More Details of FY23 Testbed Setup

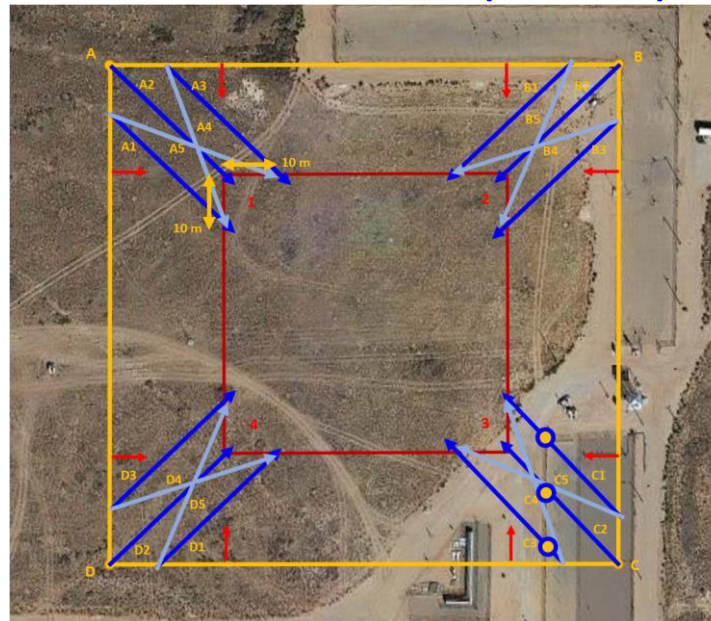


FY23 Testbed and Tests (732 Tests)

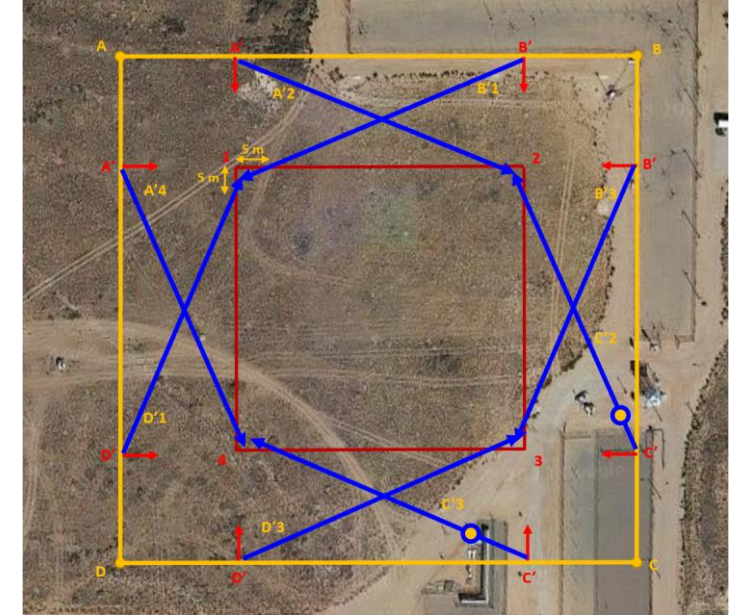
Test Set 1: Perpendicular Tests (420 Tests)



Test Set 2: Corner Tests (120 Tests)



Test Set 3: Diagonal Tests (192 Tests)



Test Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	Hits	Ps		
Distance (m)	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87	90	93	96	99	100				
Walk 3'/sec																																							
Run (as Fast as Safe)																																							
Ball Drag (Belly Crawl)																																							

Test Matrix for Test Set 1: Section A' to B'



12-inch aluminum sphere (ball drag) simulating a belly crawler

FY23 Test Results to Be Reported

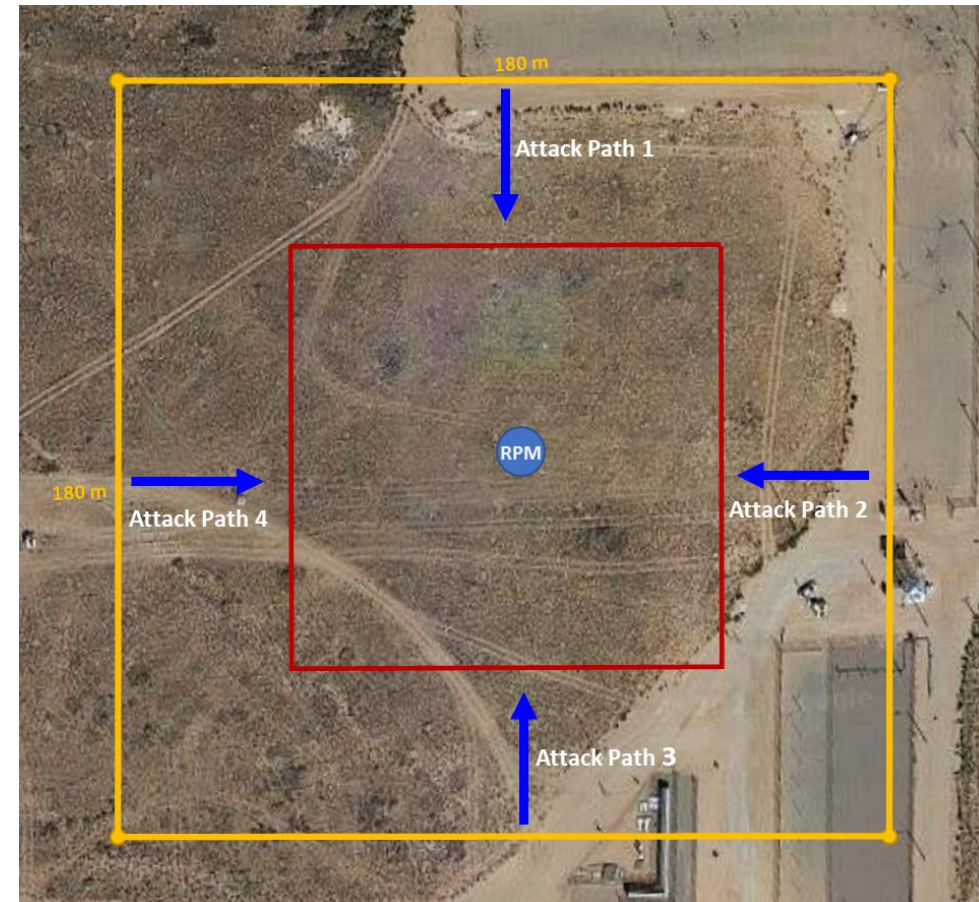
Single Intruder Tests

		Number of Attempts	Number of Detections	Probability of Detection with 95% Lower Confidence Level
Section A' to B'	Test Set 1 (Perpendicular)			
Three Other Sections	Walker	35		
105 Tests per Section	Runner	35		
	Ball Drag (Belly Crawler)	35		
Corner A	Test Set 2 (Corner)			
Three Other Corners	Walker	16		
48 Tests Per Section	Runner	16		
	Ball Drag (Belly Crawler)	16		
Section A' to B'	Test Set 3 (Diagonal)			
Three Other Sections	Walker	10		
30 Tests per Section	Runner	10		
	Ball Drag (Belly Crawler)	10		

Multi-Intruder Tests

Attack Paths	1,2	1,2,3	1,2,3,4
DMA Detections	1-Yes 2-Yes	1-Yes 2-Yes 3-Yes	1-Yes 2-Yes 3-Yes 4-Yes

Multi-Intruder Test Attack Path





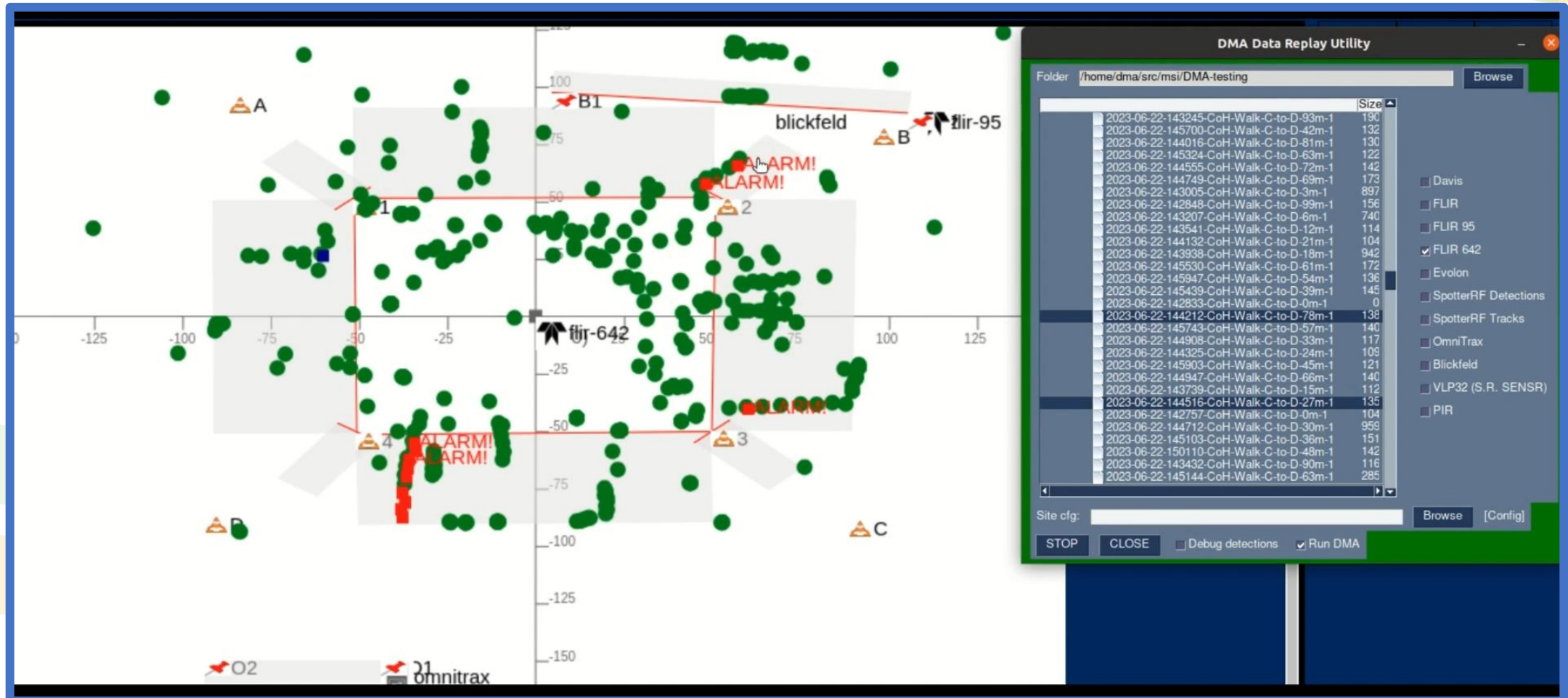
Single Intruder Video

The screenshot displays a video player interface showing a site map. The map features a central area with a red border and four corner markers labeled A, B, C, and D. A red arrow points to a location labeled 'blickfeld' with a 'flir-95' camera icon. A red alert box with the text 'INTRUDER!!' is visible. The map also shows 'flir-642' and 'O2' markers. A 'DMA Data Replay Utility' window is overlaid on the right side of the video player. This window shows a file browser for the folder '/home/dma/src/msi/DMA-testing' with a list of files and folders. The list includes various CoH-Run-D and CoH-Run-DPrime files with their respective sizes. A 'Run DMA' button is checked, and there are 'STOP' and 'CLOSE' buttons at the bottom.

File Name	Size
2023-06-29-094922-CoH-Run-D-to-A-42m-1	846
2023-06-29-095625-CoH-Run-D-to-A-72m-1	168
2023-06-29-091544-CoH-Run-D-to-A-27m-1	902
2023-06-29-100528-CoH-Run-D-to-A-48m-1	152
2023-06-29-094853-CoH-Run-D-to-A-15m-1	873
2023-06-29-095019-CoH-Run-D-to-A-96m-1	136
2023-06-29-100556-CoH-Run-D-to-A-75m-1	199
2023-06-29-092315-CoH-Run-D-to-A-30m-1	964
2023-06-29-095555-CoH-Run-D-to-A-45m-1	106
2023-06-29-095523-CoH-Run-D-to-A-18m-1	988
2023-06-29-101330-CoH-Run-D-to-A-78m-1	184
2023-06-29-093536-CoH-Run-D-to-A-9m-1	114
2023-06-29-092923-CoH-Run-D-to-A-6m-1	112
2023-06-29-095702-CoH-Run-D-to-A-99m-1	106
2023-06-29-092246-CoH-Run-D-to-A-3m-1	106
2023-06-29-094218-CoH-Run-D-to-A-39m-1	935
2023-06-29-093017-CoH-Run-D-to-A-60m-1	143
2023-06-29-094244-CoH-Run-D-to-A-66m-1	137
2023-06-29-101236-CoH-Run-D-to-A-24m-1	106
2023-06-29-091511-CoH-Run-D-to-A-0m-1	109
2023-06-29-093046-CoH-Run-D-to-A-87m-1	109
2023-06-29-093634-CoH-Run-D-to-A-63m-1	129
2023-06-29-092345-CoH-Run-D-to-A-57m-1	132
2023-06-29-092952-CoH-Run-D-to-A-33m-1	897
CoH-Run-DPrime1	
2023-07-01-075131-CoH-Run-DPrime1-1	217
2023-07-01-075245-CoH-Run-DPrime1-2	198
CoH-Run-DPrime3	
2023-07-01-081741-CoH-Run-DPrime3-2	274



Multi-Intruder Video

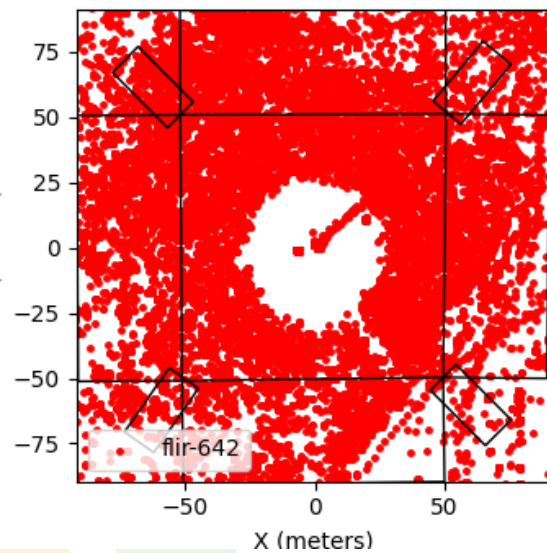




FY23 Test Results to Be Reported (NAR)

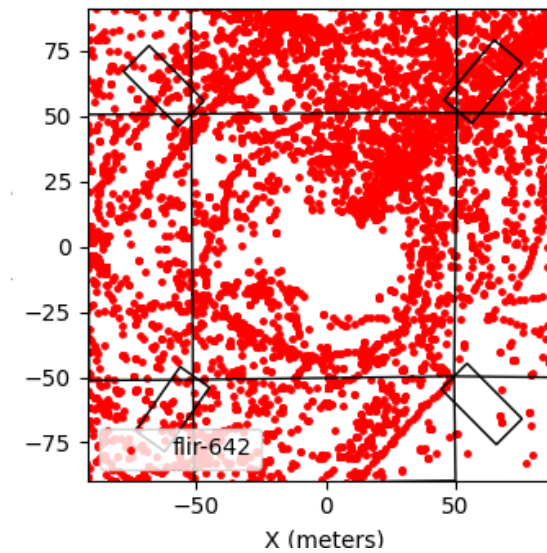
	NAR Collection	Nuisance Alarms From Wind	Nuisance Alarms From Rain	Nuisance Alarms From Wildlife	Nuisance Alarms From Other	Total Nuisance Alarms	Average NAR Per Day	Average NAR Per Day Not Including Wildlife
Radar	≈ 60 Days					≈ 10,000,000	≈ 167,000	≈ 167,000
DMA	≈ 60 Days							

2023-06-21-143443-NAR Detections



~1.2 million alarm points from the radar
Estimated "0" DMA nuisance alarms

2023-06-27-203958-NAR Detections



~0.39 million alarm points from the radar
Estimated "0" DMA nuisance alarms



FY24 Planned Activities

- Install four (4) bi-spectral cameras in testbed; re-run subset of tests to verify camera coverage
- Collect NAR with four (4) bi-spectral cameras
- Ask for input from Licensees and NRC on how they want alarms displayed and desired camera coverage for multiple simultaneous intruders
- Provide reports and data packages to Licensees to support Security Plans for SMR builds
- Invite NRC, Licensees, and DOE to see and run their own attack scenarios
- Possibly travel to SMR build sites to assess viability of DPIDS and potential pilot deployment
- Address any NRC or Licensee concerns
- Support NRC in updating intrusion detection requirements/policy when requested
- Continue DMA-fused drone detection as funding becomes available



FY23 Activities – Fused UAS Sensors – Passive RF

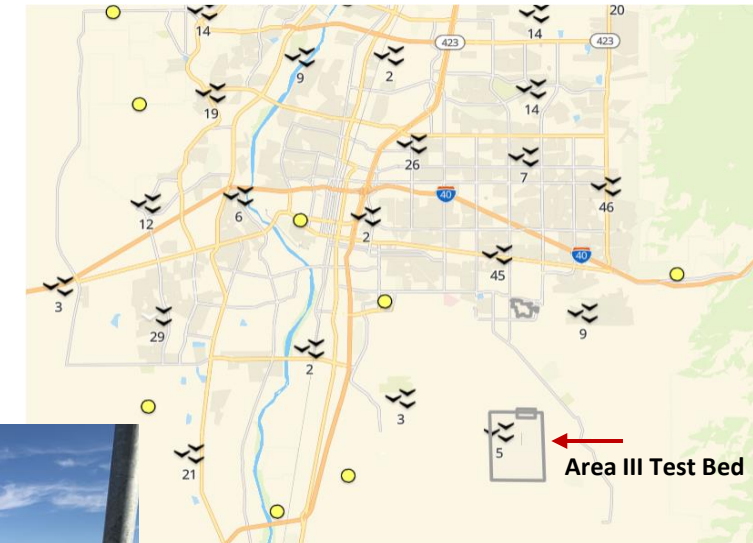


Advanced Reactor Security – UAS Detection Fusing Passive RF and Radar

Goal: Demonstrate fusion of UAS detection technologies, Fortem Radar and Wind Talker Passive RF, demonstrating reliable detection with low NAR

Wind Talker Passive RF

- Has longer detection range than radar, about 10,000 m for a DJI
- Not as prone to nuisance alarms as Radar
- Omni-directional
- Detects RF signals from the controller on the ground and the UAS
- **Does not detect aircraft, birds, cars, pedestrians**
- **If not a DJI, no detection** – must be in its DJI library
- **If inertial or visual navigation, no detection** (future threat)



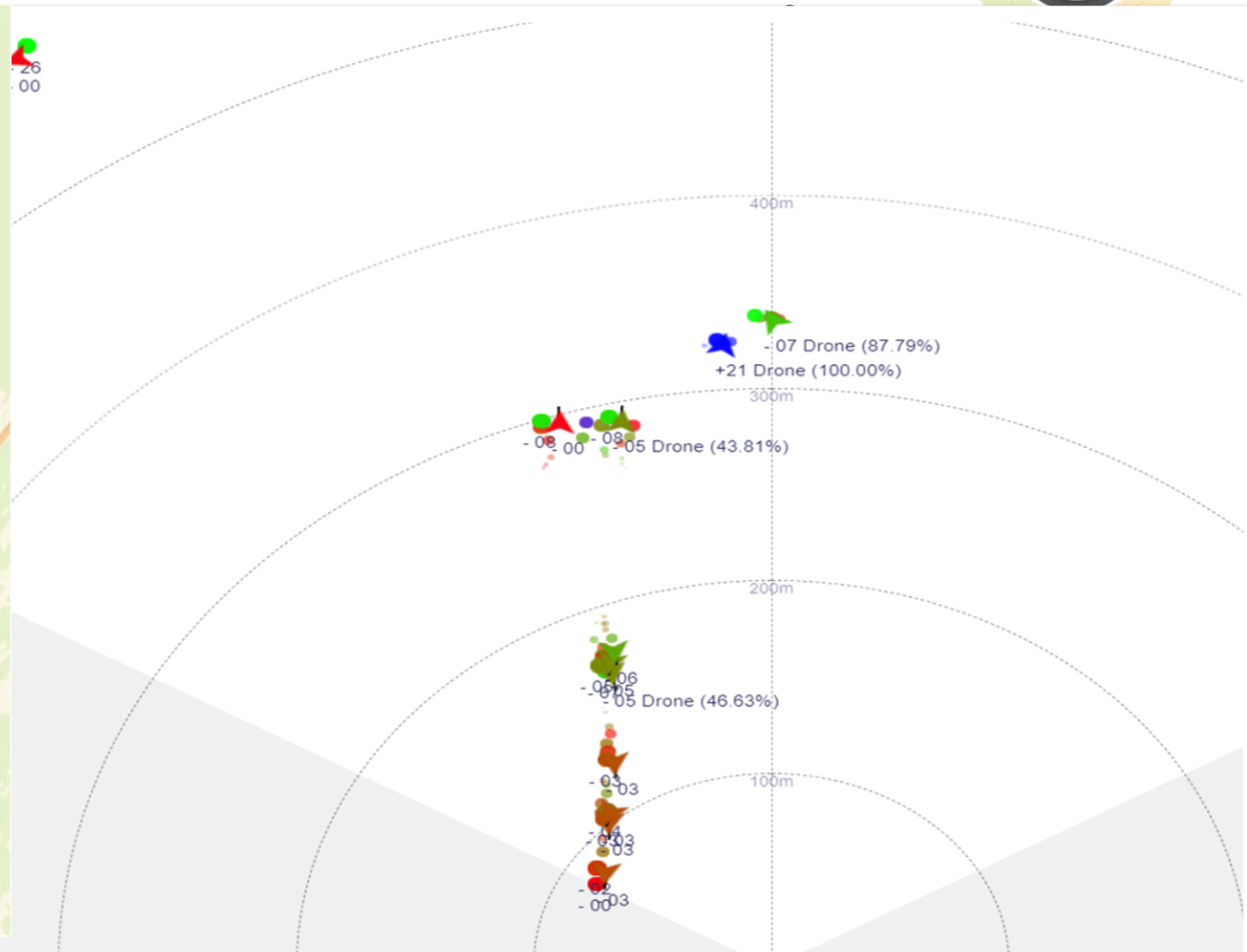
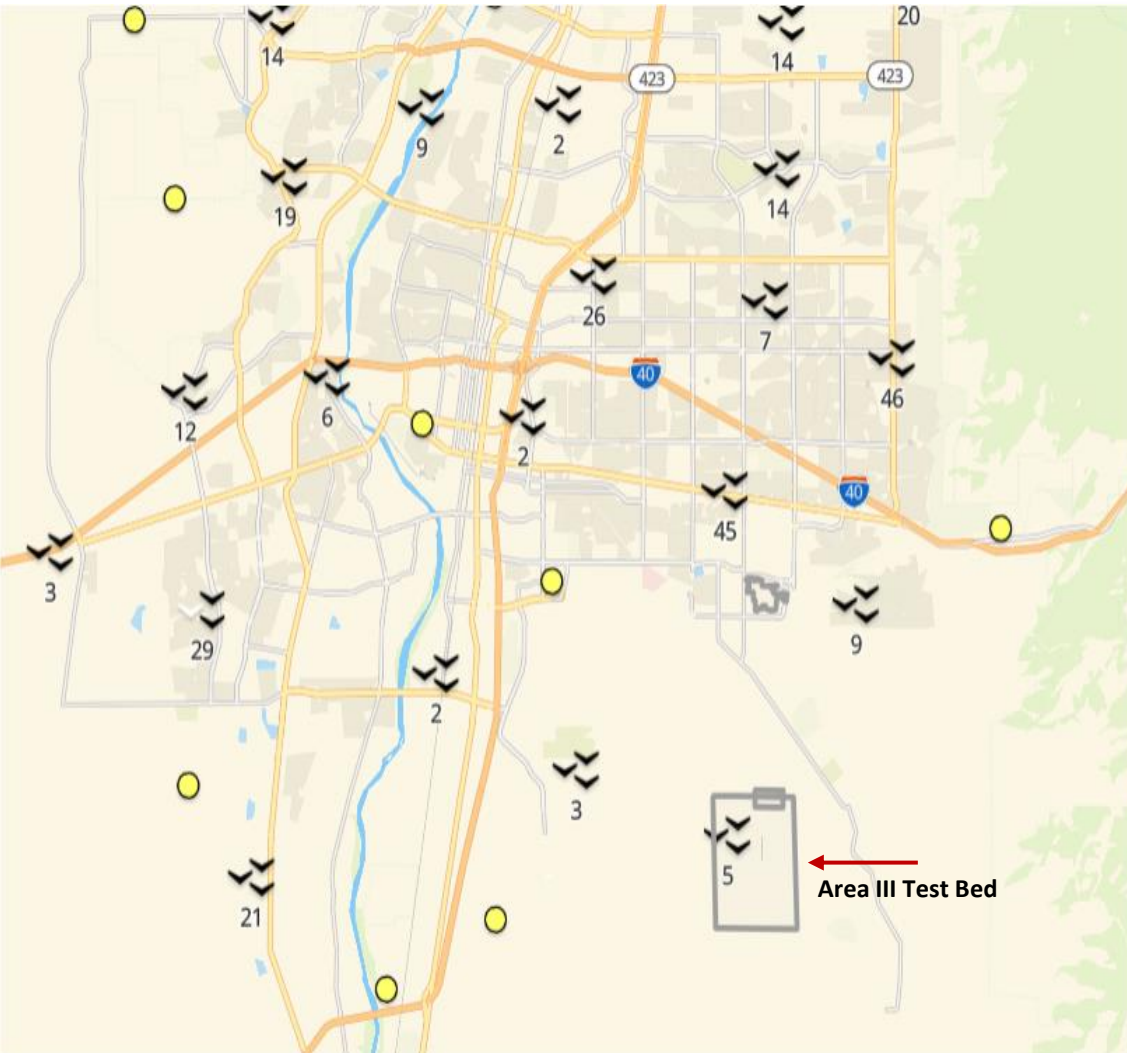
Wind Talker Display of UAVs Detected



Wind Talker Mounted in Area III Testbed

FY23 Activities – Advanced Intrusion Detection

Contrast in Information Provided By Passive RF and Radar



Example of DMA-Fused Drone Detection

Fusing Fortem Radar and Passive RF Windtalker



Location C – start of test 400 m from Hypothetical Site Boundary

DMA Alarms at ≈ 150 m from Hypothetical Site Boundary

Sparse Windtalker Data “+”

One Radar Hit before DMA Alarms “x”

